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A REPORT OF WATER POLLUTION IN THE UPPER MISSOURI DRAINAGE BASIN

Public Health Service
Cincinnati, Ohio

May 1952

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For Clean Water — "One River, One Plan"

UPPER MISSOURI RIVER DRAINAGE BASIN

A COOPERATIVE STATE-FEDERAL REPORT ON WATER POLLUTION

MAY 1952

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MONTANA
Board Of Health

FEDERAL SECURITY AGENCY
Public Health Service

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Public Health Service
Water pollution series

25 A Report of water pollution in the Upper Missouri Drainage Basin, prepared by Montana State Board of Health, Public Health Service, Division of Water Pollution Control, Missouri Drainage Office. May 1952. [Title on cover is:For clean water-- "One river, one plan", Upper Missouri River Drainage Basin, a cooperative state-federal report on water pollution.]

FOREWORD

UPPER MISSOURI RIVER BASIN

From the main and secondary ranges of the majestic Rocky Mountains come the clear mountain streams which combine near Three Forks, Montana, to form one of the most important rivers in the United States--the Missouri. On its way through Montana the Missouri River flows through scenic canyons and beautiful valleys into the great plains area of the State. Its tributaries rise in the mountain wildernesses which cannot be equaled in scenic grandeur--Glacier and Yellowstone National Parks.

Tourists from all over the world travel to Montana to enjoy vacations and recreational pastimes in or near the parks and other areas of the Rockies.

The high mountain areas offer excellent summer grazing lands in the high valleys and mountain plateaus. The land bordering the Missouri and its tributaries has been developed into fertile farm land by extensive irrigation practice. Immense acres have been and are being used for dry farming agriculture.

Many communities situated in the Upper Missouri Basin rely on the Missouri River and its tributaries as sources of domestic water supplies. Several industrial enterprises are dependent upon the use of watercourses within the Basin.

To protect the health of the people in Montana and of our neighbors, unnecessary pollution of streams in the Basin must be eliminated. In addition to the health of the people is the importance of the beauty and aesthetic and healthful quality of our recreation areas, our fish and wildlife, and the need for a satisfactory water for irrigation and industrial uses.

Every Montana citizen is urged to thoughtfully consider the facts presented in this report concerning the pollution and the plan for pollution abatement in the Upper Missouri Basin.

/s/ G. D. Carlyle Thompson
G. D. Carlyle Thompson, M.D.
Executive Officer

A REPORT OF WATER POLLUTION

IN THE

UPPER MISSOURI DRAINAGE BASIN

Prepared by

MONTANA STATE BOARD OF HEALTH
Division of Environmental Sanitation

PUBLIC HEALTH SERVICE
Division of Water Pollution Control
Missouri Drainage Basin Office

Federal Security Agency
Public Health Service
MAY 1952

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INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal agencies, with State and interstate water pollution control agencies and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters. Due regard must also be given to improvements necessary to conserve the waters for public water supplies, propagation of fish and aquatic life, recreational purposes, agricultural and other legitimate uses.

This report is produced under the cosponsorship of the Montana State Board of Health and the Public Health Service. It is based on data available as of January 1, 1952, on sources of pollution, treatment facilities employed, and stream conditions. The report also presents information concerning use of water resources, pollution entering water resources and resulting damages, benefits which may result from pollution prevention and abatement, pollution prevention measures in effect and those which are needed.

Data and knowledge now available are sufficient to permit the immediate solution of most of the pollution problems within the Upper Missouri River Basin without awaiting the results of additional surveys and studies.

A sincere effort has been made to present a fair picture of the water pollution problems in the Upper Missouri River Basin and to present reasonable conclusions and recommendations. It is our hope that this report, as a step in the cooperative development of an ultimate comprehensive water pollution control program, will help in safeguarding our water resources.

ACKNOWLEDGMENTS

The cooperation of the State water pollution control agency of Montana in furnishing data for this report is acknowledged with appreciation.

Acknowledgment is also made to the Corps of Engineers, U. S. Army, Department of Defense; Bureau of Reclamation, Fish and Wildlife Service, and Geological Survey, Department of Interior; the Weather Bureau, and Bureau of Census, Department of Commerce, whose published reports furnished much of the information contained herein on the history, hydrology, stream discharges, population trends, and economic development of the Upper Missouri Basin.

Thanks is also tendered to the reviewing agencies, whose comments have materially aided the preparation of the report. These include the Corps of Engineers, Missouri River Division Office, Omaha, Nebraska; Bureau of Reclamation, Region 6, Billings, Montana; National Park

Service, Omaha, Nebraska; Fish and Wildlife Service, Billings, Montana; Federal Power Commission, Chicago, Illinois; Department of Agriculture, Lincoln, Nebraska; Department of Commerce, Denver, Colorado; the Division of Water Pollution Control, Public Health Service, Washington, D. C.; the offices of the Montana State Engineer; and the Montana Fish and Game Commission.

SUMMARY

The Upper Missouri Basin contains the headwaters of the Missouri River and has an area of approximately 80,200 square miles; 72,000 square miles of which lie in Montana, about 8,000 square miles in Canada, and a very small portion in Wyoming. Approximately 600 miles of the Missouri River traverse the Basin as measured from its origin at the junction of the Madison, Jefferson, and Gallatin Rivers downstream to the mouth of the Milk River. The western extremity of the area is mountainous while the central and eastern portions are high plains. Elevations vary from 2,000 to 11,000 feet.

The natural resources are many and great. The mountains are covered with extensive forests, and considerable quantities of gold, silver, lead, zinc, coal, and phosphate are mined from them each year. Oil and gas are produced from widely scattered fields. Snow-fed streams flowing downward from the mountains are used to generate large quantities of electrical power and to provide water for numerous irrigation projects. Soils of high fertility are found in numerous places, but in most instances need water in order to produce abundant yields of wheat, alfalfa, sugar beets and similar crops. The natural beauty of the mountains and waterways is becoming an increasingly important tourist attraction, as revenue in Montana from the tourist trade now closely rivals that from agriculture or industry.

Much of the Basin is semiarid to arid, with most of the precipitation occurring as snowfall. Streams originating in and flowing through the mountainous sections generally have stable flows while those originating in and flowing through the high plains usually have smaller and more erratic flows. Water conservation is necessary in much of the area to provide for domestic needs, irrigation, power production, livestock watering, and recreation, including fishing, hunting, swimming, and boating. The more stable headwater streams, together with mountain lakes, provide outstanding trout fishing.

The potential of the water resources is being developed by local, State, and national interests. Development is greatly enhanced by the Missouri River Basin water and land conservation and development program which proposes to construct 19 new reservoirs in the region. Some of the reservoirs have not as yet been authorized. The tremendous Fort Peck Reservoir has been in service since 1938. Its prime purpose has been to supply water for navigation and to ameliorate flood flows in the Lower Missouri River, the middle and lower Mississippi River, and incidentally to produce power. Most of the new reservoirs will be multiple-purpose projects.

The Upper Basin is relatively sparsely populated, averaging less than 3.6 people per square mile. Its major cities are Great Falls,

Helena, and Bozeman, Montana, with 1950 populations of about 39,000, 17,500, and 11,250 people respectively. Principal industries include the purification of copper, zinc, lead, silver and gold; refining of petroleum; flour milling; and beet sugar production. The grazing of livestock on the vast pasture lands was one of the earliest occupations and remains an important agricultural pursuit.

Forty-six municipalities discharge wastes estimated to total 133,000 population equivalents before treatment. Industrial wastes from 10 separately sewered outlets are estimated to have a population equivalent exceeding 16,600. Thirty-two of the 46 municipalities and 9 of the industries provide some treatment. Existing municipal sewage treatment works reduce pollution approximately 9 percent. Inorganic materials, such as silt, rock flour, chemicals and metallic ions, are being discharged from industries engaged in the mining and purification of metals.

Municipal pollution has been responsible for local damages in a number of locations, the most serious of which has been pollution entering the Milk River at and below Havre, Montana. This situation has been improved by recently installed facilities for sewage and waste treatment, however a considerable load of organic material as recently as 1951 has been discharged to the river from sugar refining operations[1] at Chinook. In some of the streams used as sources of water supply oil pollution has caused taste and odor problems. Mine tailings have been responsible for reduction in fish population of several headwater streams. There is no interstate pollution and there has been no reported pollution in the streams entering the United States from Canada.

The Montana State water pollution control agency has made steady progress in controlling and abating pollution, but has been somewhat hampered by inadequate State legislation. Pollution control in Montana is limited by legislation to those situations where the safety of a public water supply is threatened, or where another type of public health hazard can be demonstrated.

The construction of pollution abatement facilities is not at the present time deterred by State statutes governing limitations on municipal indebtedness. The cost of constructing 15 new municipal sewage treatment works, enlarging and adding to 7 treatment plants, replacing 11 sewage treatment works, installing 3 new industrial waste treatment plants, and additions to 4 existing waste treating plants at industrial installations, is conservatively estimated at $2,850,000. This figure does not include operation and maintenance charges nor cost of [illegible] sewers. During the past four years five new sewage treatment plants were constructed in the area to provide sewage treatment for 27,000 people. Table 1 summarizes treatment needs in the Upper Missouri Basin.

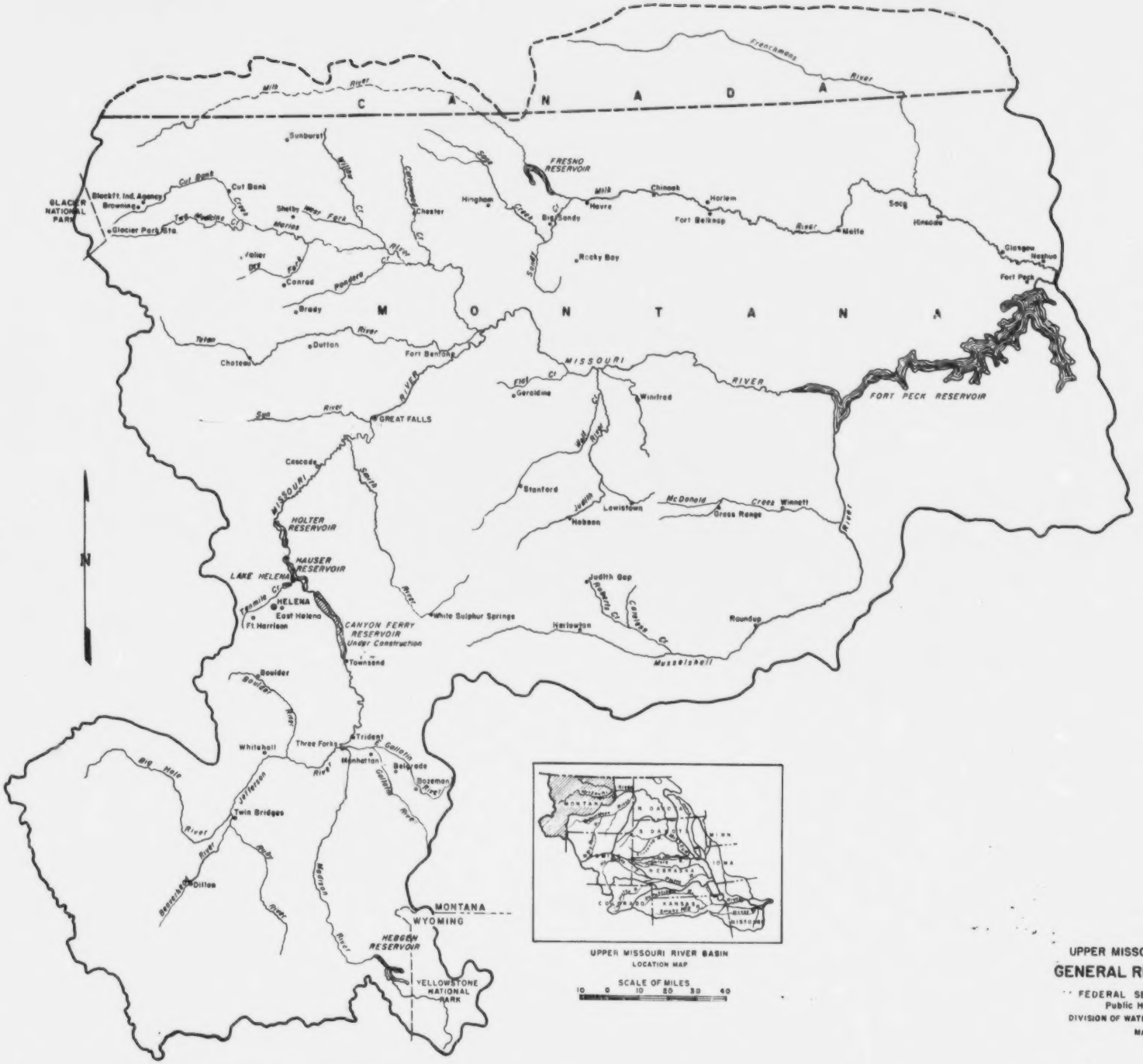
[1] Plant being dismantled, will not operate after 1951 season.

Table 1. Upper Missouri River Basin - Municipalities and industries needing improvements for abatement of pollution - January 1952

Name and location	Population served	Improvements needed *
Montana		
Belgrade	620	Replace (Primary)
Big Sandy	700	Replace (Secondary)
Bozeman		
Pea Cannery	16,600 (P.E.)**	New Plant (Equiv. to Secondary)
Browning	1,600	Enlargement (Primary)
Black Foot Indian Agency	300	Replace (Secondary)
Cascade	400	New Plant (Primary)
Chester	700	New Plant (Secondary) (In planning stage)
Choteau	1,600	Replace (Primary)
Conrad	1,800	Replace (Secondary)
Cut Bank	3,700	Replace (Secondary)
Dillon	3,200	New Plant (Primary)
East Helena	1,150	Enlargement (Primary)
Fort Benton	1,500	New Plant (Primary)
Fort Peck	1,100	New Plant (Primary)
Geraldine	370	Enlargement (Primary)
Glacier Park Station	200	Additions (Primary)
Glasgow	3,800	New Plant (Primary)
Great Falls	39,200	New Plant (Primary)
Great Northern R.R. Shops	-	New Plant (Primary oil separator)
Phillips Oil Refinery	-	Additions (oil separator)
A.C.M. Reduction Plant	-	Additions
Great Falls Meat Co.	Unknown	New plant or other controls
Harlowton	1,700	Replace (Primary)
C.M.St.P.& P. R.R. Co.	-	Addition (oil separator)
Havre		
Great Northern R.R. Shops	-	Additions (oil separators)
Helena	17,600	New Plant (Primary)
Hinsdale	700	Additions (Primary)
Lewistown	6,500	Additions (Secondary)
Malta	2,000	New Plant (Primary)
Manhattan	700	Replace (Primary)
Montana State Training School (Boulder)	500	New Plant (Secondary)
Montana State Orphans Home (Twin Bridges)	350	New Plant (Secondary)
Roundup	2,800	Replace (Primary)
Saco	500	New Plant (Secondary)
Shelby	3,000	New Plant (Secondary)
Three Forks	1,100	New Plant (Primary)
Townsend	1,300	Additions (Primary)
Veterans Administration Hospital (Fort Harrison)	300	Replace (Secondary)
White Sulphur Springs	1,000	New Plant (Secondary)
Winnett	400	Replace (Primary)

*Degree of treatment as tentatively recommended by the State Water Pollution Control Agency.

**Population equivalent (P.E.) of organic industrial waste produced.



UPPER MISSOURI RIVER BASIN
LOCATION MAP

UPPER MISSOURI RIVER BASIN
GENERAL REFERENCE MAP

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 1

CONCLUSIONS

1. The great reserves of natural resources in the Upper Missouri Basin indicate that an expanded economy, principally in manufacturing and processing, may be expected. Industrial development has proceeded rapidly in recent years.

2. An increase in both domestic and industrial waste will accompany any expansion in manufacturing and processing industries.

3. Natural grandeur, hunting, and fishing will continue to attract an ever increasing number of tourists and sportsmen. If the value of these resources is to be fully protected, pollution of the waterways must be properly controlled.

4. The extensive use of surface waters for domestic and municipal water supply and for irrigation emphasizes the need for pollution control to prevent bacteriological contamination and objectionable tastes and odors in water supplies. Adequate pollution control will enhance these uses.

5. The location of sources of waste and degree of treatment needed to properly control pollution has been established except for a very few small communities and minor industries relatively unimportant in the total pollution control program. The data indicate that 15 new municipal sewage treatment plants, 7 enlargements or additions, and 11 replacements are needed in the Basin to provide adequate sewage treatment. Three new industrial waste treatment plants, and enlargement or improvement of four existing industrial waste treatment plants are considered necessary. The cost of providing these facilities is conservatively estimated at $2,850,000.

6. Existing legislation is not sufficiently broad in scope to permit the State water pollution control agency to develop and effectuate a comprehensive water pollution control program in Montana.

7. Existing sewage treatment consists largely of removing the settleable solids prior to the discharge of sewage into the streams. Only three treatment plants in the Basin provide more than primary treatment. Low flow augmentation in the Milk River from Havre to Fort Belknap in addition to primary sewage treatment and industrial waste treatment has been found necessary to insure a water supply of proper quality for communities downstream from Havre.

8. Approximately 58 percent of the sewered population is contributing untreated waste to the waterways of the Basin. This includes the two largest municipalities within the Basin.

9. No interstate or international pollution problems are known to exist at the present time.

RECOMMENDATIONS

It is recommended that:

1. There be enacted by the Montana State Legislature legislation authorizing the development and ordering the execution of a comprehensive State-wide program of water pollution control.

2. Funds and personnel as necessary to permit development and execution of a comprehensive program of pollution abatement be made available to the State agency responsible for such a program.

3. a. Sewage treatment facilities be provided in accordance with recommendations of the Montana State Board of Health at the following cities and towns in Montana:

Cascade	Chester	Dillon
Fort Benton	Fort Peck	Glasgow
Great Falls	Helena	Malta
Saco	Shelby	Three Forks

Montana State Training School at Boulder
White Sulphur Springs
Montana State Orphans Home at Twin Bridges

b. Existing sewage treatment plants be replaced by new plants as recommended by the Montana State Board of Health at the following locations:

Belgrade	Big Sandy	Choteau
Blackfoot Indian Agency (Browning)		Conrad
Cut Bank	Harlowton	Manhattan
Roundup	Winnett	

Veterans Administration Hospital, Fort Harrison

c. Additional treatment units or enlargement of existing units as recommended by the Montana State Board of Health be provided at:

Browning	East Helena	Geraldine
Lewistown	Townsend	Hinsdale

Glacier Park Station

4. Adequate pollution control measures as recommended by Montana State Board of Health be installed at the following industries:

Bozeman Pea Cannery, Bozeman
Great Northern Railroad Shops, Great Falls
Phillips Oil Refinery, Great Falls
A. C. M. Reduction Plant, Great Falls
Great Falls Meat Company, Great Falls
C. M. St.Paul & Pacific Railroad Company, Harlowton
Great Northern Railroad Shops, Havre.

5. Special investigational work be carried out to determine water pollution control needs for the mining operations near Basin, Dillon, Virginia City, Sheridan, Maiden Rock, and Neihart, Montana.

GENERAL DESCRIPTION

Historical Background

That part of the State of Montana included in the Upper Missouri Basin was originally a part of the Louisiana Purchase ceded by France to the United States in 1803. There is little factual evidence to indicate that the area was visited by white man prior to 1804. It may have been visited as early as 1743 by the Verendrye Brothers, however it is generally agreed that this party went only into the southeastern part of the State if at all.

In 1804 the expedition under Lewis and Clark ascended the Missouri River and explored much of the central and western section of the present State of Montana. In 1810 Manuel Lisa of the Missouri Fur Company established a trading post near the present site of Trident, but due to disagreements among his followers the trading post was abandoned, and not until 1827 was another trading post located in the confines of the Upper Missouri Basin. In 1846 Fort Benton was built at the foot of the Great Falls of the Missouri. On July 17, 1859, the Steamboat Chippewa under its own power reached the flats below Fort Benton. Prior to this time all supplies were hauled from the mouth of the Yellowstone River to Fort Benton, or from other points farther down the Missouri River.

There were earlier rumors that gold was present in the region, but it was not until 1862 that it was actually discovered in the sands of Gold Creek, Grasshopper Creek, and at White's Bar. News of these discoveries traveled fast and gold seekers stampeded into Montana. This influx of population was naturally resisted by the Indians and there were numerous skirmishes between the miners and Indians. These struggles were climaxed when the Government troops under General Miles defeated Chief Joseph of the Nez Perces in 1877.

The first railroad into Montana was the Utah & Northern, now the Union Pacific. The Northern Pacific was completed to Great Falls in 1883, and the Great Northern, formerly known as the Montana Central, reached Helena in 1887. The coming of the railroads brought farmers, merchants, and miners who gradually replaced the gold seekers and stabilized the population. In 1889 the Territory of Montana was granted statehood.

Rich deposits of copper were discovered near Butte in 1880, and a smelting works was erected at Great Falls shortly thereafter. Since then the mining and smelting of copper has been one of the principal occupations of the area. Although the mines are located outside the Upper Missouri Basin, much of the smelting and refining of the ore is carried on at the Great Falls plant where ample supplies of electric power and water are available.

Much of the progress in the Basin is associated with the development and use of its waters, particularly for municipal and industrial supplies, transportation, power and irrigation. Montana is one of the few States that has significant wildlife resources, both hunting and fishing, of interest to the entire nation. The public expects to find in Montana an outlet for its zeal for scenic enjoyment, fishing and

hunting. Two great national parks are accessible through the Basin. To insure that these great natural resources will continue to serve the public it is necessary that the streams, lakes, and scenery be protected from the inroads of pollution. Their continued use by the people of the nation represents a very large economic return to the State of Montana. These resources, if lost through mismanagement, can never be fully restored to their natural state.

Physical Description

The Upper Missouri Basin lies between meridians 106° W. and 114° W., and parallels 44° N. and 50° N. It occupies a total of 80,200 square miles, 72,000 square miles of which are in the State of Montana, a very small portion lies within Yellowstone National Park, Wyoming, and 8,000 square miles are in Canada. The area is 400 miles in length with a maximum width of 250 miles. The Missouri River within the Basin is approximately 600 miles long.

For purposes of this report, the Upper Missouri Basin is terminated immediately below the mouth of the Milk River. The Missouri River is considered to be formed near Three Forks, Montana, by the junction of the Jefferson, Madison, and Gallatin Rivers, although some geographers consider the main stem of the Missouri to extend above Three Forks through the Jefferson and its tributaries, namely the Beaver Head and Red Rock Rivers, to the source of the Red Rock River as the ultimate beginning of the Mississippi-Missouri River system. From Three Forks the river flows in a generally northern and northeasterly direction for a distance of about 400 miles, thence easterly to the bounds of the Sub-Basin.

The river lies in the northern Rocky Mountain region from its headwaters to the vicinity of Great Falls, Montana. The Missouri enters the Great Plains region 30 miles upstream from Great Falls at a point called "The Gates to the Mountains," as named by Lewis and Clark. It is a clear, swift flowing stream with a discharge of considerable magnitude.

The Jefferson River has a total drainage area of 9,520 square miles and a length of 248 miles. The Jefferson is formed by the junction of the Beaver Head and Big Hole Rivers just north of Twin Bridges, Montana, from whence it flows northeast to its junction with the Madison and Gallatin Rivers near Three Forks, Montana. Its principal tributary is the Boulder River which rises in the vicinity of Deer Lodge National Forest along the eastern slope of the Continental Divide. Other tributaries of importance are the Big Hole River, Pipestone, White Tail, South Boulder, and Willow Creeks. The average slope of the Jefferson River is 19.3 feet per mile.

The Madison River, which is formed by the junction of the Firehole and Gibbon Rivers in Yellowstone National Park in Wyoming, flows west to the vicinity of Cliff Lake where it turns north to its junction with the Jefferson and Gallatin Rivers. It drains a total of 2,520 square miles. The Firehole River rises near the Upper Geyser Basin in Yellowstone Park and is fed by the geysers and hot springs of Upper and Lower Geyser Basins. The Gibbon River rises near Grebe Lake in Yellowstone Park from whence it flows southwest to join the Firehole River.

Throughout much of its length the Madison has formed steep-sided canyons and medium size valleys. The flood plains are flanked by series of coarse gravel terraces rising to about 150 feet above the river. The river is 183 miles in length and has a slope of approximately 25.1 feet per mile.

The Gallatin River is formed by the junction of the West Gallatin and East Gallatin Rivers. The West Gallatin River rises in the northwest corner of Yellowstone National Park and joins the East Gallatin at Logan, Montana. Other principal tributaries of the Gallatin system are Taylor Fork, West Fork, Spanish Creek, and Hyalite Creek. The Gallatin drains a total area of 1,840 square miles and through the West Gallatin, its principal tributary, is approximately 120 miles in length. Its average slope is 41.7 feet per mile.

The major tributaries of the Missouri River below Three Forks, Montana, include the Dearborn, Smith, Sun, Marias, Judith, Musselshell and Milk Rivers. The Marias, Musselshell and Milk Rivers are the largest of the group, each having more than 9,000 square miles of drainage area.

The Milk River rises in the extreme northwesterly portion of the Upper Missouri Basin and flows northward into Canada and includes in its drainage area the extreme southern portions of the province of Alberta, and the southwestern corner of the province of Saskatchewan. It then returns across the International Boundary into Montana and flows in a southeastwardly direction to join the Missouri River at a point about 11 miles downstream from Fort Peck Dam. It drains an area of 24,326 square miles, of which 8,279 square miles are located in Canada. The stream is 729 miles in length and has an average slope of 6.8 feet per mile. The principal tributaries of the Milk River include Big Sandy, Lodge, Battle, White Water, Frenchmans, Beaver, and Rock Creeks. For most of its length the river lies in the high plains region. Its flow is normally small but varies between great extremes.

Climate

Due to great differences in elevation throughout the Upper Missouri Basin (2,000 to 11,000 feet) climatic conditions vary widely. Precipitation varies from 10 to 20 inches, with the greatest amount falling in the mountains. The great plains area seldom receives more than 14 inches of moisture per year. Seventy to 75 percent of the precipitation in the plains region occurs between April 1 and September 1. Snowfall ranges from 30 inches in the Milk River Basin to as much as 10 to 15 feet in the mountainous area.

The average growing season varies from 29 days at Gold Butte, Montana, to a maximum of 185 days in the lower plains. Average of the lower plains region, however, is from 115 to 125 days. Frosts occur every month of the year in some portions of the Basin. The temperature range is likewise great. The winters are normally very cold with short, hot summers. In the Milk River Basin the mean monthly January temperature is 11.1° while the July mean monthly temperature is 69.7° F. The winters throughout the area are frequently moderated with warm, dry winds known as "Chinooks" which rapidly melt the snow, dry the ground, and introduce short periods of pleasant weather.

Many of the streams of the Basin are fed from natural hot springs. Such springs are found at Bozeman and Hot Springs in Gallatin County; Potosi, Ziegler, and Barkell Hot Springs in Madison County; Elkhorn and Jackson Hot Springs in Beaverhead County; Pipestone, Alhambra, and Boulder Hot Springs in Jefferson County; White Sulphur Springs in Meagher County; Helena Springs in Lewis and Clark County, and in the Geyser Basin of Yellowstone National Park. Natural springs at Great Falls, Lewistown, and Toston, Montana, have flows of 300, 110, and 60 cubic feet per second respectively. Hydrologic data showing average flows and minimum mean monthly flows are presented in table 2.

Mineral resources are found in almost every section of the Basin. These include gold, silver, copper, lead, zinc, phosphate, and coal. Extensive coal and natural gas fields have been located in the central and northwestern sections.

Economic Development

Early records of the Upper Missouri Basin indicate that the Missouri Fur Company built a trading post near the present site of Three Forks, Montana, in 1810. This venture was apparently the first organized attempt to develop the resources of the Upper Missouri River.

For many years after Fort Benton became the head of navigation on the Missouri River large quantities of supplies were shipped via water from St. Louis to Fort Benton where they were transferred to overland routes for their destination. It was not until the 1870s that the Basin began to develop rapidly. The discovery of gold and the coming of the railroads were largely responsible for the increased activity. As the excitement of the gold discoveries subsided many of the immigrants turned to other occupations, principally that of raising cattle. When it became known that the soils were inherently fertile and that excellent crops of wheat could be raised, much of the land was converted to dry-land farming.

In the early part of the 20th century oil was discovered, introducing a new industry which at once added greatly to the economy of the region. In 1950 the Basin had approximately 250,000 inhabitants, which represents about 50 percent of the total population of the State of Montana. There has been little recent over-all change in the population, however it is apparent that the rural areas are losing and the urban areas are gaining inhabitants. It is also evident that the manufacturing and processing of materials is increasing at a rather high rate. Statistics for the State of Montana indicate that manufactured products have increased about 77 percent since 1939. The number of people engaged in the manufacturing industry has increased about 56 percent in the same period. The present per capita income for the State of Montana has increased 197 percent over that of 1939. This is the fifth greatest increase in the nation. The average individual income in Montana for 1949 exceeded the national average by about $358, and was the third highest in the nation. These statistics indicate that both agriculture and industry are thriving in Montana. Although agriculture is still the predominant factor in the economy of the Basin, industry and the tourist trade are pressing it closely. About one million acres of agricultural land are irrigated, 20 million acres are used for

Table 2. Upper Missouri River Basin - Hydrologic data - observed minimum monthly mean flows occurring for a calendar month during winter (Dec. Jan. Feb.) and summer (June, July, Aug. and Sept.) for period of record

River	Years of records studied	Area drained sq. miles	c.f.s.** average discharge	Mean monthly low flow in c.f.s. observed	
				Winter	Summer
Beaver Head River Blaine, Mont.	13	3,630	395	329	24.2
Jefferson River Sappington, Mont.	19	8,980	2,133	900	160
*Madison River McAllister, Mont.	10	2,180	1,570	-	-
Gallatin River Logan, Mont.	24	1,805	906	380	160
*Missouri River Fort Benton, Mont.	30	24,600	7,690	3,000	1,600
Marias River Shelby, Mont.	17	2,610	774	58	86
Judith River Utica, Mont.	22	331	52	C 21	2.9
Musselshell River Harlowton, Mont.	24	1,130	145	10.0	0
*Milk River Lohman, Mont.	14	6,070	248	7.3	50

*Streams now regulated by upstream reservoirs. Data from U.S.G.S. Publications.

**Cubic feet per second.

Table 3. Upper Missouri River Basin - Population of cities*

City	1920	1930	1940	1950
Belgrade	499	533	618	663
Belt	967	810	744	702
Big Sandy	589	633	596	743
Boulder	682	926	510	1,017
Bozeman	6,183	6,855	8,665	11,252
Browning	986	1,172	1,825	1,674
Cascade	465	520	419	447
Chester	402	387	548	733
Chinook	1,217	1,320	2,051	2,299
Choteau	1,043	926	1,181	1,613
Conrad	988	1,499	1,471	1,854
Cut Bank	1,181	845	2,509	3,719
Denton	431	345	406	435
Dillon	2,701	2,422	3,014	3,079
Dodson	365	249	397	330
Dutton	-	-	447	431
East Helena		1,039	1,143	1,214
Fort Benton	1,065	1,109	1,227	1,508
Fort Peck	-	-	-	1,150
Geraldine	354	279	262	374
Glasgow	2,054	2,216	3,799	3,810
Great Falls	24,121	28,822	29,928	39,006
Harlem	721	708	1,166	1,103
Harlowton	1,856	1,473	1,547	1,718
Havre	5,429	6,372	6,427	8,094
Helena	12,037	11,803	15,056	17,498
Hingham	154	251	205	214
Hobson	-	240	239	205
Judith Gap	522	288	212	175
Kevin	-	324	360	351
Lavina	-	148	799	195
Lewistown	6,120	5,358	5,874	6,540
Lima	476	459	554	483
Malta	1,427	1,342	2,215	2,085
Manhattan	591	501	646	716
Melstone	477	215	203	195
Moore	355	288	241	224
Nashua	272	351	943	691
Neihart	749	169	466	289
Roundup	2,434	2,577	2,644	2,852
Ryegate	405	292	348	339
Saco	425	506	452	539
Sheridan	538	521	597	572
Shelby	537	2,004	2,538	3,058
Stanford	300	509	529	542
Sunburst	-	486	709	845
Three Forks	1,071	884	876	1,106
Townsend	897	735	1,309	1,316
Twin Bridges	755	671	534	497
Valier	613	575	641	710
Virginia City	342	242	380	323
Whitehall	629	553	818	1,553
White Sulphur Springs	574	575	858	1,015
Winnett	316	408	399	407

*Statistics taken from U. S. Census Reports. List includes only those having a community water supply, a community sewer system or a population of 300 or more people. All communities are located in Montana.

pasturing livestock, 6,500,000 acres are in national forest, and 9,800,000 acres are farmed by dry land methods.

A potent factor in the rapid development of industry in recent years has been a ready source of cheap electrical power. The great natural falls of the Missouri River at Great Falls have been harnessed and are producing large quantities of hydroelectric power. Private and public development of regulatory works has enabled the production of hydroelectric power at Fort Peck, Holter, and Houser Dams. Upon completion of the presently authorized Missouri Basin Development Program a much greater development of the power potential of the Missouri River and its tributaries in this area will be realized.

The natural scenery of the area has been a very great influence on its economy. Portions of the Yellowstone and Glacier National Parks are located in this Basin, in addition to which there are large areas of mountainous and forested lands of great scenic value. Income realized from the tourist trade was the third largest source of revenue in Montana in 1948, and probably enjoys an even higher place among the State's revenue producers in 1951. An important factor in the recreational industry is the superb hunting and fishing attractions.

The Upper Missouri Basin with its immense mineral resources, large oil reserves, great forests, fertile soils, water resources, power potential, great scenic and recreational values, and its fish and wildlife resources, should enjoy a very favorable economic future.

According to the Economic Development Atlas* the State of Montana in 1947 was below the national average in economic development, but since 1939 it has been developing at a rate greater than the national average. Table 3 presents the population of municipalities within the Upper Missouri River Basin.

USES OF WATER RESOURCES

The earliest uses of water in the Basin were for transportation and hydraulic mining. The use of water for placer mining, or jetting of gold from the creek banks, was the basis for the present Law of Water Rights in Montana. The first water right established in the Upper Missouri Basin was acquired on Elkhorn Creek in Jefferson County in 1861.

The Missouri River and its tributaries are used as sources of public water supply for 18 cities and towns and to remove the liquid wastes of the sewered municipalities and industries. See tables 4 and 5.

Irrigation is an extremely important use of water in this area. There are about a million acres under irrigation. An additional one and one-half million acres are considered irrigable. Large irrigation projects now exist in the Milk River Valley, along the Sun and Marias Rivers, and in the valleys of the Madison, Gallatin, and Jefferson Rivers. Plans have been completed for additional irrigation along the

*Published by the United States Department of Commerce.

Table 4. Upper Missouri River Basin - Municipal water supplies from surface sources

Municipality	Location	Source	Treatment
Basin	Montana	Creek	N
Bozeman	Montana	Creek	D
Brady	Montana	Impounded Reservoir	D
Butte	Montana	*Big Hole River	-
Chinook	Montana	Milk River	CFD
Conrad	Montana	Lake Francis	D
Cut Bank	Montana	Cut Bank Creek	CFD
East Helena	Montana	Creek	D
Fort Belknap	Montana	Milk River	-
Fort Benton	Montana	Missouri River	CFD
Fort Peck	Montana	Missouri River	CFD
Glacier Park Station	Montana	Creek	D
Great Falls	Montana	Missouri River	CFD
Harlem	Montana	Milk River	CFD
Havre	Montana	Milk River	CF
Heihart	Montana	Creek	N
Townsend	Montana	Creek	D
White Sulphur Springs	Montana	Creek	N

*Water is taken from the Big Hole River to supplement the Butte supply. Butte, Montana, is located in the Columbia River Basin.

N - No Treatment
D - Disinfection with Calorine
CF - Coagulation and Filtration

Table 5. Upper Missouri River Basin - Municipal water supplies from ground sources

Municipality	Location	Source	Treatment
Belgrade	Montana	DW	N
Belt	Montana	Dug Well	N
Big Sandy	Montana	Dug and DW	D
Browning	Montana	Spring and DW	N
Cascade	Montana	Spring and DW	D
Chester	Montana	DW	N
Choteau	Montana	Dug Wells	N
Denton	Montana	Springs	N
Dillon	Montana	DW and Creek	D
Dodson	Montana	Springs	N
Dutton	Montana	Dug Well	N
Fairfield	Montana	Inf. Gallery	D
Geraldine	Montana	Springs	D
Glasgow	Montana	DW	D
*Helena	Montana	Springs, Dug Wells, Creeks	D
Harlowton	Montana	DW	N
Highwood	Montana	DW	N
Hinsdale	Montana	DW	N
Judith Gap	Montana	DW	N
Kevin	Montana	Springs	N
Lewistown	Montana	Springs	N
Lima	Montana	Springs	D
Malta	Montana	Dug Wells	D
Manhattan	Montana	Springs	D
Melstone	Montana	Dug Well	D
Moore	Montana	Dug Well	N
Nashua	Montana	Dug Wells	-
Rocky Boy Indian Agency	Montana	Springs	-
Roundup	Montana	Inf. Gallery and Dug Well	D
Ryegate	Montana	Dug Well	N
Saco	Montana	Spring and DW	D
Shelby	Montana	DW	N
Sheridan	Montana	Spring and Creek	N
Stanford	Montana	DW	N
Sunburst	Montana	DW	N
State Training School (Boulder)	Montana	DW and Creek	D
State Orphans Home (Twin Bridges)	Montana	DW	D
Three Forks	Montana	DW	-
Trident	Montana	Dug Wells	N
Twin Bridges	Montana	DW	N
Valier	Montana	Dw and Dug Wells	N
Virginia City	Montana	Springs	N
Whitehall	Montana	DW	N
Winnett	Montana	DW	N

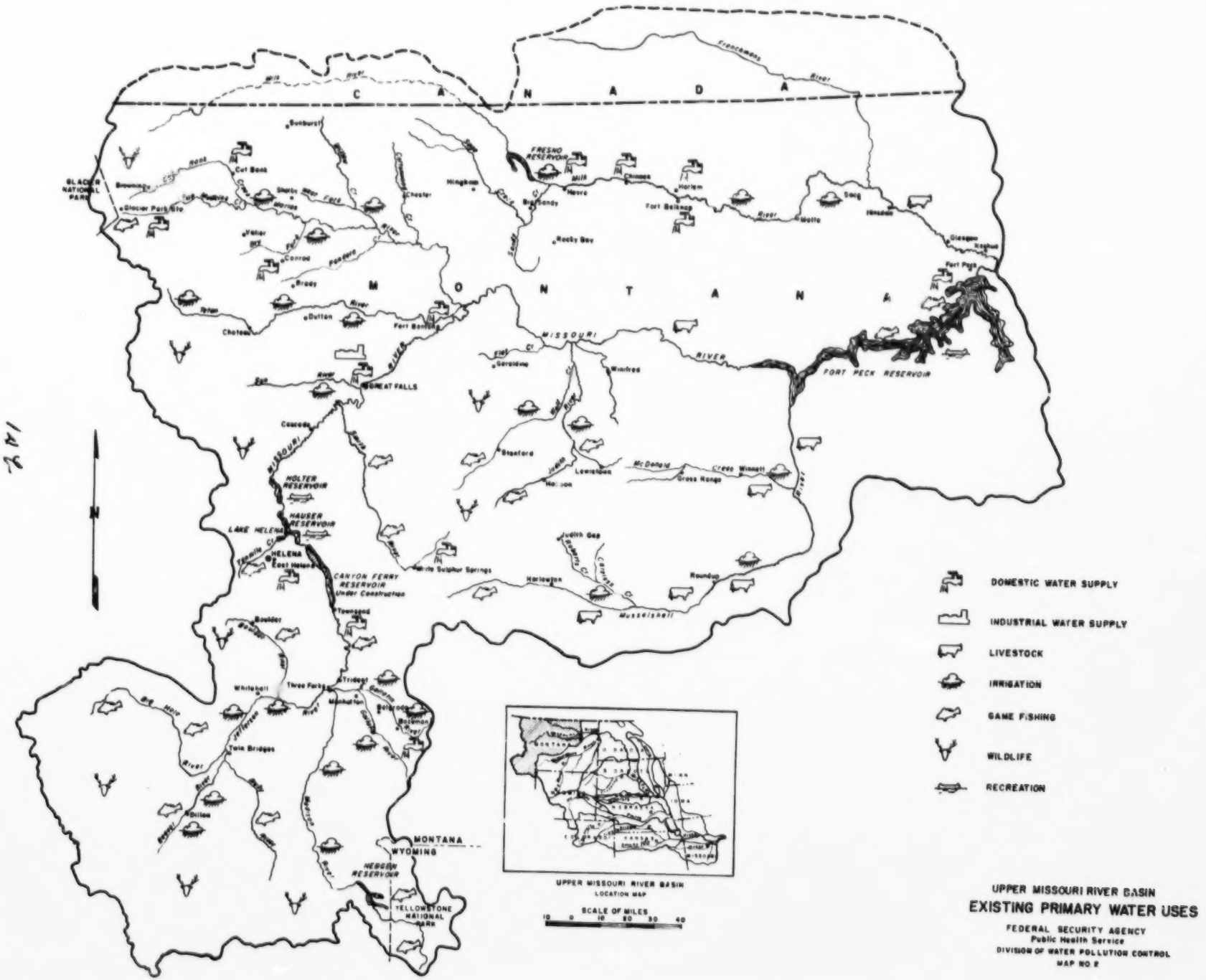
DW - Drilled Wells

N - No Treatment

D - Disinfection

Inf. - Infiltration

* The water supply of Helena is obtained from four sources including Ten Mile Creek and Oro Fino Gulch, springs and wells.



UPPER MISSOURI RIVER BASIN
LOCATION MAP

UPPER MISSOURI RIVER BASIN
EXISTING PRIMARY WATER USES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 2

Missouri River, in the Sun River Valley, and in the Marias River Valley. Numerous other small projects have been proposed but not yet authorized.

There is considerable hydroelectric power development in the region. The principal power plants are located at Black Eagle, Ryan, Rainbow, and Marony Dams in the vicinity of Great Falls. Other regulatory works and smaller power plants are located at Hebgen Reservoir on Madison River and Houser and Holter Dams on the Missouri River. Downstream at Fort Peck Dam a 50,000 kilowatt generating plant has been installed by the Corps of Engineers. The present generating capacity of hydroelectric power installations totals 260,700 kilowatts. The Bureau of Reclamation is constructing a large multiple-purpose reservoir at Canyon Ferry. After installation of generators at Canyon Ferry, together with proposed increases in the power production capacity at Fort Peck, a total of more than 445,000 kilowatts of power will be available from the waters of the Upper Missouri Basin.

The Anaconda Copper Mining Company has a large smelter at Black Eagle, Montana, across the river from Great Falls, which electrolitically purifies copper and zinc. The smelter was located here in order to utilize the electricity produced at the nearby hydroelectric power plants, and to have available a sufficient volume of water for cooling purposes. The oil refinery at Great Falls is also dependent upon the river for its water supply. Water power is used to operate flour mills at Lewistown and Bozeman, Montana.

Trout fishing in the Upper Missouri Basin constitutes some of the finest in the nation. Thousands of anglers are attracted yearly by the splendid fishing afforded them in the Big Hole, Gallatin, Beaver Head, Wise, Madison, Sun and Dearborn Rivers. The streams mentioned are particularly well known, however there are innumerable tributaries that also offer excellent fishing. Rainbow, cutthroat, eastern brook, and brown trout and mountain white fish are found in abundance.

Some portions of the Basin have excellent big game hunting, particularly the Sun River region. Montana permits regular hunting seasons on grizzly bear, black bear, elk, mule deer, and whitetail deer. There are also moose, mountain goat, and big horn sheep. Herds of antelope are scattered throughout the area. Other wild game of note include lynx, bobcat, muskrats, marten, raccoons, weasels, wolverine, cougar, coyote, wolf, beaver, mink, otter, pheasants, grouse and rabbits.

There is little commercial navigation in the streams, however a considerable fleet of small power craft operate on Hebgen and Holter Lakes for the benefit of the tourist trade. The lake formed by Holter Dam extends through the "Gates to the Mountains," a scenic and historical area very popular with tourists. Hebgen Lake is considered to be one of the best fishing lakes in the entire Basin. Recreational areas now being developed on Hebgen Lake and on Fort Peck Reservoir for boating, swimming, and fishing will undoubtedly attract a greater number of tourists.

POLLUTION CONTRIBUTED TO WATER RESOURCES

Waste is contributed to the Missouri River and its tributaries within the Upper Missouri Basin from 46 municipalities and 10 separately sewered industries (see tables 6 and 7). The municipalities serve approximately 131,000 people and numerous small industries connected to city sewers. The organic population equivalent of industrial waste from the small industries has not been determined in all cases. Separately sewered industry discharges a population equivalent of about 16,600. Municipal and industrial treatment facilities reduce the amount of waste reaching waterways, however polluting material equivalent in organic content to that produced by more than 137,000 people is discharged into the streams. Wastes from an equivalent population of over 75,000 receive no treatment. Inorganic wastes, such as rock flour and mine tailings, metallic ions, acids and alkalies are responsible for serious pollution in several headwater streams.

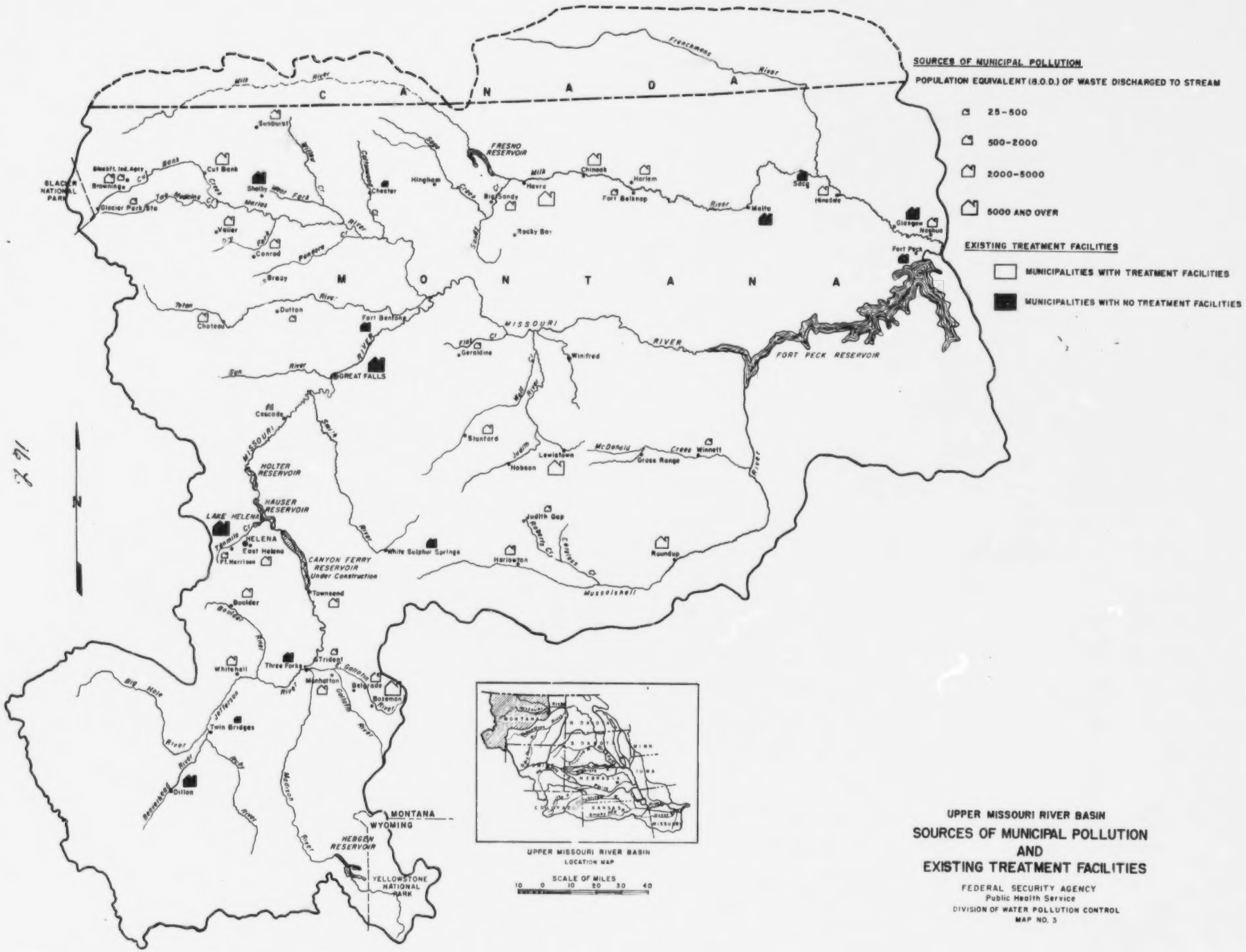
The stream reaches most seriously affected by organic pollution are located on the Milk River between Havre and Fort Belknap, Prickly Pear Creek below Helena, the Missouri River below Great Falls, Blacktail Creek below Dillon, and Spring Creek below Lewistown, Montana. Objectional mine wastes are reportedly entering Horse Prairie Creek, Ruby River, Boulder River and Belt Creek.

There is no known pollution contributing to interstate or international stream pollution. Most of the pollution problems are localized, affecting stream reaches for only a relatively short distance. Pollution from sources in Canada have not been considered in this report.

DAMAGES TO WATER RESOURCES FROM POLLUTION

Prior to corrective measures instituted in 1949-1950, the Milk River below Havre, Montana, was the most intensively polluted stream reach in the Upper Missouri Basin. Within a river distance of approximately 50 miles, the Cities of Havre and Chinook, the Utah-Idaho Sugar Refining Company, and the Towns of Harlem and Fort Belknap discharged untreated waste to the river. Severe water supply problems developed for the towns of Harlem and Fort Belknap, and to a lesser extent for Chinook, whenever low flows and high concentrations of waste occurred in the Milk River. Pollution of the section of the Milk River between Havre and Fort Belknap has long been a source of trouble. This was first evidenced when a water-borne typhoid epidemic struck Harlem, Montana, in 1910. During winter months the residents of Harlem had to purchase water in containers for drinking and cooking purposes because the river water was so polluted that it was impossible to treat it. The Fort Belknap Indian Agency obtained its water supply from the Milk River for domestic purposes until 1937, when it was necessary to abandon the river source because of its extremely poor quality.

Since the principal pollutant at Harlem and Belknap was the refining wastes from the U & I Sugar Company's plant at Chinook, the Montana State Board of Health recommended that the more potent wastes be impounded and held until river discharges were high enough to permit assimilation without undue damage. In 1940 the sugar beet refining


SOURCES OF MUNICIPAL POLLUTION
POPULATION EQUIVALENT (B.O.D.) OF WASTE DISCHARGED TO STREAM
25-500
500-2000
2000-5000
5000 AND OVER
EXISTING TREATMENT FACILITIES
MUNICIPALITIES WITH TREATMENT FACILITIES
MUNICIPALITIES WITH NO TREATMENT FACILITIES
C A N A D A
M O N T A N A
MISSOURI RIVER
FORT PECK RESERVOIR
FRESNO RESERVOIR
GREAT FALLS
HOLTER RESERVOIR
HAUSER RESERVOIR
LAKE HELENA
HELENA
CANYON FERRY RESERVOIR
Under Construction
HEBGEN RESERVOIR
YELLOWSTONE NATIONAL PARK
GLACIER NATIONAL PARK
MONTANA
WYOMING
UPPER MISSOURI RIVER BASIN
LOCATION MAP
SCALE OF MILES
UPPER MISSOURI RIVER BASIN
SOURCES OF MUNICIPAL POLLUTION
AND
EXISTING TREATMENT FACILITIES
FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 3

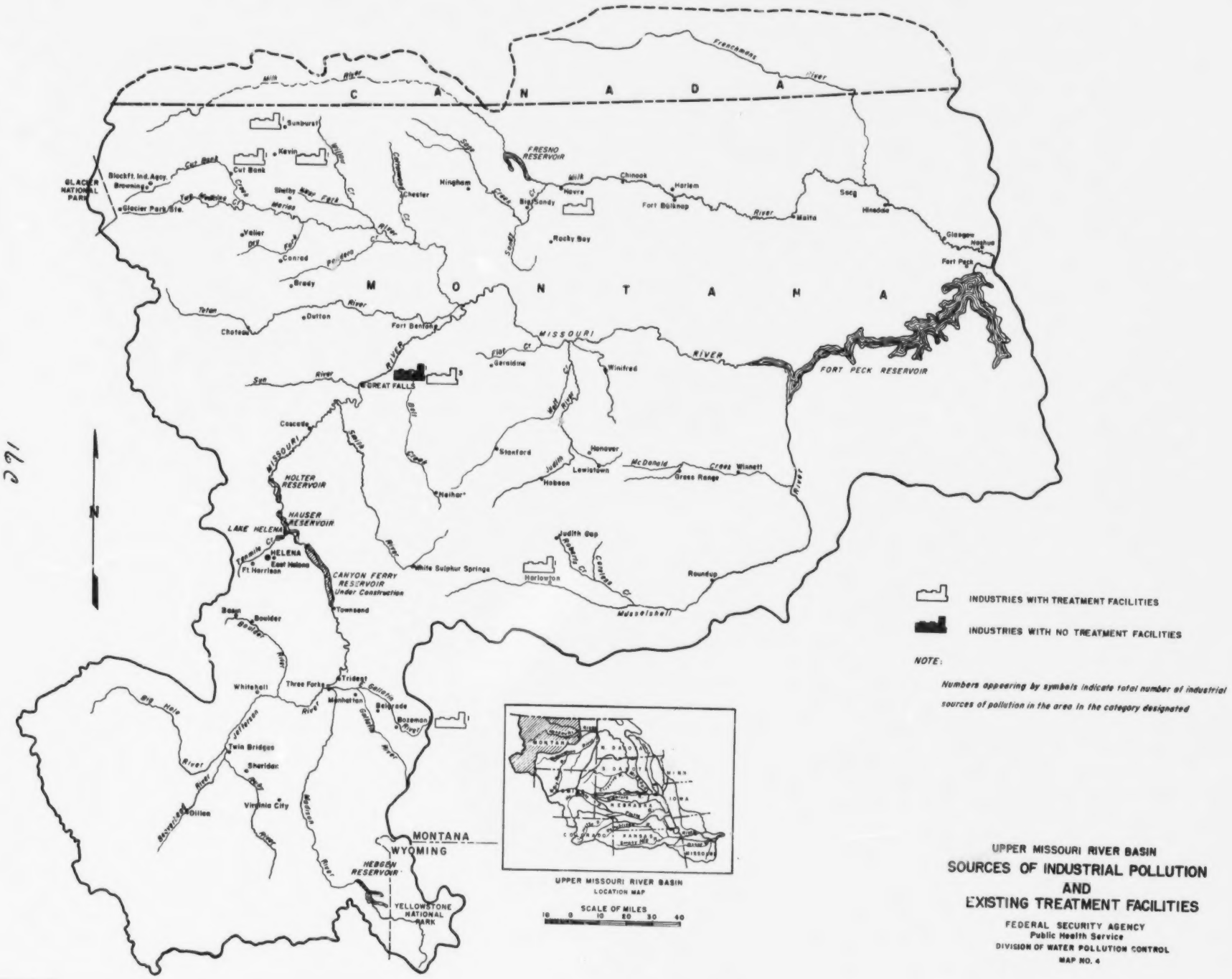

C A N A D A
M O N T A N A
Milk River
Frenchmans River
Sunburst
Kevin
Cut Bank
Blackft. Ind. Agcy
Browning
Glacier Park Sta.
GLACIER NATIONAL PARK
Shelby
Marias
Valier
Conrad
Brady
Dutton
Choteau
Teton River
Willow Cr.
Cottonwood Cr.
Chester
Hingham
Sage Creek
FRESNO RESERVOIR
Big Sandy
Havre
Milk
Rocky Boy
Chinook
Harlem
Fort Belknap
Malta
Saco
Hinsdale
Glasgow
Nashua
Fort Peck
Fort Benton
MISSOURI RIVER
Sun River
GREAT FALLS
Geraldine
Winifred
FORT PECK RESERVOIR
Cascade
Belt Creek
Stanford
Hanover
Lewistown
Judith
McDonald
Grass Range
Crooks
Winnett
Hobson
Neihart
HOLTER RESERVOIR
HAUSER RESERVOIR
LAKE HELENA
Tenmile Cr.
HELENA
East Helena
Ft Harrison
CANYON FERRY RESERVOIR
Under Construction
White Sulphur Springs
Townsend
Judith Gap
Roundup
Musselshell
Boulder
Whitehall
Three Forks
Manhattan
Belgrade
Bozeman
Gallatin River
Big Hole River
Jefferson River
Twin Bridges
Sheridan
Dillon
Beaverhead River
Ruby River
Virginia City
Madison River
MONTANA
WYOMING
HEBGEN RESERVOIR
YELLOWSTONE NATIONAL PARK
N
INDUSTRIES WITH TREATMENT FACILITIES
INDUSTRIES WITH NO TREATMENT FACILITIES
NOTE:
Numbers appearing by symbols indicate total number of industrial sources of pollution in the area in the category designated
UPPER MISSOURI RIVER BASIN
LOCATION MAP
SCALE OF MILES
10 0 10 20 30 40
UPPER MISSOURI RIVER BASIN
SOURCES OF INDUSTRIAL POLLUTION
AND
EXISTING TREATMENT FACILITIES
FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 4

Table 6. Upper Missouri River Basin - Basic data on sources of municipal pollution

Receiving stream and name and location of municipality	River miles from mouth	Sewered population P. E.	Estimated untreated waste P.E.	Treatment provided	Adequacy of treatment Cap'y	Adequacy of treatment Oper.	P. E. Discharged (Est.)	Treatment needs	Community action
Missouri River									
Jefferson River	2,464								
Beaverhead River									
Dillon, Montana		3,200	3,240	None	-	-	3,240	NP	Planning initiated
State Orphans Home (Twin Bridges, Mont.)		350	350	None	-	-	350	NP	Inactive
Whitetail Creek									
Whitehall, Mont.		1,500	1,700	Primary	Sat.	Uns.	1,500	-	-
Boulder River									
Montana State Training School (Boulder)		500	514	Primary	Uns.	Uns.	475	NP	Inactive
Madison River									
Three Forks, Mont.	2.0	1,100	1,100	None	-	-	1,100	NP	Inactive
Gallatin River	2,464								
East Gallatin	10								
Bozeman, Mont.	31	12,000	12,144	Primary	Sat.	Sat.	8,400	-	-
Belgrade, Mont.	21	620	710	Primary	Uns.	Uns.	526	R	Inactive
Manhattan, Mont.	9	700	750	Primary	Uns.	Uns.	600	R	Inactive
Missouri River									
Trident, Mont.	2,463	160	160	Primary	Sat.	Sat.	150	-	-
Townsend, Mont.	2,423	1,300	1,300	Primary	Uns.	Uns.	1,225	A	Inactive
Prickly Pear Creek	2,372								
East Helena, Mont.	90	1,150	1,150	Primary	Uns.	Sat.	1,035	E	Inactive
Veterans Adm. Hosp. (Fort Harrison)		300	300	Primary	Uns.	Uns.	270	R	Inactive
Helena, Mont.	7	17,600	17,700	None	-	-	17,700	NP	Plans approved
Cascade, Mont.	2,306	400	400	None	-	-	400	NP	Planning initiated
Smith River									
White Sulfur Spgs., Mont.		1,000	1,000	None	-	-	1,000	NP	Inactive
Missouri River									
Great Falls, Mont.	2,248	39,200	40,300	None	-	-	40,300	NP	Inactive
Fort Benton, Mont.	2,202	1,500	1,500	None	-	-	1,500	NP	Inactive
Marias River	2,181								
Two Medicine River									
Glacier Park Sta.		200	200	Primary	Uns.	Sat.	175	A	Inactive
Cut Bank Creek									
Browning, Mont.		1,600	1,600	Primary	Uns.	Sat.	1,300	E	Inactive
Willow Creek									
Blackfoot Indian Agcy. (Browning)	3	300	300	Primary	Uns.	Uns.	270	R	Inactive
Cut Bank Creek									
Cut Bank, Mont.		3,700	3,700	Primary	Uns.	Uns.	3,300	R	Inactive
Shelby, Mont.	168	3,000	3,000	None	-	-	3,000	NP	Inactive
Cottonwood Creek									
Chester, Mont.		700	700	None	-	-	700	NP	Planning initiated
Dry Creek									
Valier, Mont.		640	640	Primary	Sat.	Sat.	575	-	-
Pondera Creek									
Dry Fork Creek									
Conrad, Mont.		1,800	1,800	Primary	Uns.	Uns.	1,600	R	Planning initiated
Teton River									
Choteau, Mont.		1,600	1,600	Primary	Uns.	Sat.	1,300	R	Inactive
Dry Fork									
Dutton, Mont.		450	450	Secondary	Sat.	Sat.	150	-	-
Missouri River									
Arrow Creek									
Flat Creek									
Geraldine, Mont.		370	370	Primary	Uns.	Uns.	300	E	Inactive
Judith River	2,114								
Big Springs Creek	35								
Lewistown, Mont.	10	6,500	6,500	Primary	Uns.	Sat.	5,600	A	Inactive
Wolf Creek	10.5								
Skull Creek	60								
Stanford, Mont.	2	500	500	Primary	Sat.	Sat.	250	-	-
Dog Creek									
Musselshell River	1,994								
Harlowton, Mont.		1,700	1,739	Primary	Uns.	Uns.	1,450	R	Inactive
Careless Creek									
Roberts Creek									
Judith Gap, Mont.		210	210	Primary	Sat.	Uns.	190	-	-
Musselshell River									
Roundup, Mont.		2,800	2,800	Primary	Uns.	Uns.	2,500	R	Inactive
Boxelder Creek									
McDonald Creek									
Winnett, Mont.		400	400	Primary	Uns.	Uns.	375	R	Inactive
Milk River	1,857								
Sunburst, Mont.		710	710	Primary	Sat.	Sat.	640	-	-
Big Sandy Creek									
Big Sandy, Mont.		700	700	Primary	Uns.	Uns.	650	R	Inactive
Sage Creek									
Milk River									
Havre, Mont.	401	8,000	8,000	Primary	Sat.	Sat.	6,800	-	-
Chinook, Mont.	363	2,200	2,332	Secondary	Sat.	Sat.	1,150	-	-
Harlem, Mont.		1,100	1,100	Secondary	Sat.	Sat.	250	-	-
Ft. Belknap		200	200	Primary	Sat.	Sat.	170	-	-
Malta, Mont.	216	2,000	2,000	None	-	-	2,000	NP	Inactive
Beaver Creek	136.4								
Saco, Mont.		500	500	None	-	-	500	NP	Inactive
Hinsdale, Mont.	121.0	700	700	Primary	Uns.	Uns.	529	A	Inactive
Glasgow, Mont		3,800	3,825	None	-	-	3,825	NP	Inactive
Nashua, Mont		700	700	Primary	Sat.	Uns.	500	-	-
Missouri River									
Fort Peck, Mont.		1,100	1,100	None	-	-	1,100	NP	Planning initiated

Note: NP - New plant
A - Additional units
E - Enlargements
R - Replacement
Sat.- Satisfactory
Uns.- Unsatisfactory

Table 7. Upper Missouri River Basin - Basic data on sources of industrial pollution

Receiving stream and name and location of industry	Type of industry	Type of waste produced	Treatment or other pollution control measures		Population equivalent discharged to watercourse	Pollution abatement measures needed	Project status
			Degree	Adequacy			
Missouri River							
Gallatin River							
East Gallatin River							
Bozeman Pea Cannery (Bozeman, Mont.)	Food & kindred products	Organic	Minor	Inadequate	16,600	New plant	Inactive
Great Northern R.R.	Misc.	Organic & Inorganic	Minor	Inadequate	Unknown	New plant	Inactive
Phillips Oil Refinery	Petroleum	Organic & Inorganic	Partial	Inadequate	Unknown	Additions	Inactive
A.C.M. Smelter	Pri. Metals	Inorganic	None	Inadequate	-	Additions	Inactive
Great Falls Meat Co. (Great Falls, Mont.)	Food & kindred products	Organic	Minor	Inadequate	-	New plant	Inactive
Marias River							
Cut Bank Creek							
Union Oil Refinery (Cut Bank, Mont.)	Petroleum	Organic & Inorganic	Complete	No waste reaches waterway		None	-
Marias River							
Oil Refinery (Kevin, Mont.)	Petroleum	Organic & Inorganic	Complete	No waste reaches waterway		None	-
Musselshell River							
Chicago, Milwaukee, St. Paul & Pacific Maint. Shops (Harlowton, Mont.)	Misc.	Organic & Inorganic	Minor	Inadequate	-	Additions	-
Milk River							
Land-locked area							
Texaco Oil Refinery (Sunburst, Mont.)	Petroleum	Organic & Inorganic	Complete	No waste reaches waterway		None	-
Milk River							
R.R. Shop (Havre, Mont.)	Misc.	Organic & Inorganic	Minor	Inadequate	-	Additions	-

company began to impound its more potent wastes including pulp screen water, pulp silo drainage, and lime cake waste. This procedure, however, proved of little value to Harlem and not until the sugar refining company constructed an impoundment for Harlem in which water from summer flows could be stored for use in the wintertime did the water supply become tolerable for domestic use. At about the same time the municipalities of Havre, Chinook, Harlem and the sugar refining company joined the Bureau of Reclamation to finance the construction of Fresno Dam now located upstream from Havre, Montana. Since the construction of the dam, flow of the river has been regulated to insure a minimum flow of 25 cubic feet per second at Havre. In addition, the cities of Havre, Chinook, and Harlem installed sewage treatment plants in 1949 and 1950.

The Great Northern Railroad Shops at Havre contribute oily wastes to the Milk River, which have increased taste and odor problems in the downstream public water supplies.

Oil wastes from the Great Northern Railroad Shops at Great Falls, Montana, have caused some damage in the Missouri River. The domestic sewage at Great Falls is also discharged untreated into the Missouri. Most of the oil and sewage solids collect in the reservoir formed by Black Eagle Dam, and the decomposition of the polluting materials cause disagreeable odors and unsightly conditions.

The City of Helena discharges untreated waste into Ten Mile and Prickly Pear Creeks. These two creeks join and later discharge their flows into Lake Helena. Both creeks below the City of Helena are little more than open sewers. The occasional flooding of the creeks spread the sewage-laden waters over lands used extensively for grazing of dairy stock and over truck garden crops and haylands. As a result of exposure of vegetable crops and dairy products to such contamination farmers have at times been prohibited from selling their produce. Nuisance conditions have also been noted in Blacktail Deer Creek, a tributary of the Beaver Head River, at and below the sewer outfall of Dillon, Montana, whenever irrigation diversions above Dillon reduce the creek's flow past the city.

The City of Cut Bank, Montana, suffers damage to its water supply when leaks occur in the crude oil line crossing Cut Bank Creek above the city's water intake.

During the canning season the pea cannery at Bozeman has been responsible for considerable pollution in the East Gallatin River.

Considerable damage to fishing has occurred in Spring Creek below Lewistown, Montana, because of a pollution contributed by that municipality. Fishing has also been damaged by undesirable mine wastes in Horse Prairie Creek, Ruby River, Boulder River, and Belt Creek. Future investigational work may reveal other streams to be damaged in a like manner.

BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

Most of the benefits which can be attributed to pollution prevention and abatement have occurred in the lower portion of the Milk River Sub-Basin. In 1940 the very critical pollution problem incurred by the discharge of sugar refining wastes into the Milk River at Chinook was eased when enough water was added from the newly constructed Fresno Reservoir to provide a minimum flow of 25 cubic feet per second at Havre. In addition to flow augmentation in the Lower Milk River, the Utah and Idaho Sugar Refining Company impounded its more potent waste, and in the past three years the Cities of Havre, Chinook, and Harlem have installed sewage treatment works. Affected communities report that, as a result of the improvements, river water is now of better quality than in any previous time in the memory of the water treatment plant operators, or about 35 years. The City of Havre, which derives its water supply from wells, now is planning to obtain water from the river, and Fort Belknap has returned to the river for its domestic water supply after abandoning that source 14 years ago.

Fishing and fish propagation has benefited by sewage treatment at Lewistown, however the present treatment works is overloaded and the discharge of inadequately treated sewage in the creek is causing conditions inimical to the highest production of fish. Adequate treatment of the municipal sewage would greatly enhance the value of Spring Creek for fishing.

Sewage treatment which is planned at Helena will greatly relieve a condition which has been troublesome to farmers and sportsmen affected by pollution in Ten Mile and Prickly Pear Creeks and Lake Helena. The removal of waste oil and the treatment of domestic sewage at Great Falls would be of benefit to residents of the Great Falls area by alleviating the nuisance conditions in the reservoir above Black Eagle Dam. Also recreational interests would be revived, land values enhanced, and added protection would be afforded the municipal water supply of Fort Benton taken from the Missouri River approximately 30 miles downstream from Great Falls.

POLLUTION PREVENTION AND ABATEMENT MEASURES IN EFFECT

Wastes from 55,300 people, or 42 percent of the total, are given some degree of treatment. Sewage and waste treating facilities have been constructed in 32 of the 46 sewered municipalities. Data pertaining to the amount and type of treatment provided at each installation are shown in tables 6 and 7. The location of each source of pollution is shown pictorially on maps 3 and 4.

The Montana State Board of Health has found it difficult to deal with recalcitrant municipalities and industries who have refused to construct sewage pollution abatement work as recommended, since State statutes limit enforcement to those sources of pollution directly affecting public health. Generally speaking, however, the policies of the State Board of Health have yielded results as is evidenced by the number of sewage treatment works installed in recent years. In

Table 8. Upper Missouri River Basin - Statistical summary of existing treatment facilities - Municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	29	29	51,560
Secondary	3	3	3,750
No treatment	14	0	75,450
TOTAL	46	32	130,760

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

Table 9. Upper Missouri River Basin - Existing treatment facilities - Industrial*

Type industry	Number of plants	Number of industrial plants having:	
		Treatment facilities	No treatment facilities
Food and kindred products	2	2	0
Petroleum	4	4	0
Miscellaneous	3	3	0
Primary metals	1	0	1

*Industries having separate outlets and discharging wastes directly to watercourse.

Table 10. Upper Missouri River Basin - Adequacy of existing treatment - Municipal and Industrial

Existing treatment facilities	Number	Adequacy with relation to:			
		Capacity		Operation	
		Satisf.	Unsatisf.	Satisf.	Unsatisf.
Municipal*	32	13	19	15	17
Industrial**	9	3	6	3	6

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

**Industries having separate outlets discharging wastes directly to watercourse.

Table 11. Upper Missouri River Basin - Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	0	-	0	-
1947	0	-	0	-
1948	1	500	0	-
1949	2	15,000	0	-
1950	2	11,500	0	-

the past three years sewage treatment works have been completed to serve more than 27,000 people. The Utah and Idaho Sugar Refining Company has been cooperative and has greatly reduced the greatest single source of pollution in the Basin by process changes and by providing storage for its extremely potent refining wastes, and by implementing final disposal by controlled release to the stream. Most of the oil refineries have provided oil separators to recover at least a portion of oil formerly lost to the streams.

Table 8 summarizes existing treatment, as to numbers of plants, the degree of treatment offered, and the number of people served by each category of treatment. Table 9 summarizes industrial waste treatment. Table 10 presents in tabular form the adequacy of the existing municipal and industrial plants, and table 11 gives the number of plants built in the period 1946-1950 together with the number of people served.

The State Board of Health has assisted municipalities in maintaining proper operational practices in sewage treatment works by offering short course schools for sewage plant operators and by consultative visits to plants. As operating problems develop, sewage plant operators are given personnel assistance and advice.

Present statutes of Montana give the State Board of Health broad authority to control pollution where it may affect public health. They do not, however, authorize control of pollution which may affect the streams for other uses. Appendix A presents an analysis of the State Laws pertaining to stream pollution. State statutes relating to municipal financing of construction, operation, and maintenance of sewage treatment works appear sufficiently liberal to meet present needs.

POLLUTION PREVENTION MEASURES NEEDED

Present water uses and increased or additional uses possible with improved water quality, together with protection of water rights and property values, largely determine the pollution prevention measures needed. The objective of water pollution control programs is to preserve or reclaim water to best serve these interests. Treatment requirements, like other aspects of water resources development, are generally influenced by economic consideration. In addition, the intangible aspects of moral obligation, aesthetic values, and nuisance conditions exert a powerful and positive influence on the justification of waste treatment facilities.

Water quality objectives have been fairly well developed for such water uses as domestic and industrial water supply, recreation, bathing, and supporting fish life. Objectives are less well defined for other uses.

Among the more important objectives of a water pollution control program is protection of water quality in streams used as sources of public water supplies. The quality of raw water is an important factor in the design of water treatment facilities and in their operation and maintenance. The factor of safety which can be incorporated in the best water treatment facility is, however, inversely proportional to the

specific concentrations of bacteria and toxic elements in water serving as the source of supply. Therefore, public health and waterworks officials generally measure water quality in terms of its bacteriological, physical, and chemical characteristics. While definite standards of raw water quality have not been adopted, the Manual of Recommended Water Sanitation Practice, Public Health Service Bulletin No. 296, 1946, recommends the following practices: Underground waters not subject to any possible contamination and meeting in all respects the requirements of the Public Health Service Drinking Water Standards as shown by satisfactory, regular, and frequent sanitary inspections and laboratory tests, require no treatment. Underground or surface waters which are subject to a low degree of contamination not averaging more than 50 coliforms (M.P.N.) per 100 ml. of sample in any month and meeting the requirements of the Public Health Service Drinking Water Standards in all other respects should receive a minimum of simple chlorination or its equivalent. Waters which require filtration treatment for turbidity and color removal, waters of high or variable chlorine demand, and waters polluted by sewage to such an extent as to be inadmissible in the prior groups, but containing numbers of coliform bacteria averaging not more than 5,000 coliforms (M.P.N.) per 100 ml. of sample in any one month and exceeding this number in not more than 20 percent of the samples examined in any one month, should be provided complete rapid sand filtration treatment or its equivalent, together with continuous postchlorination. Waters which meet the requirements of the previous statement with respect to the limiting monthly average coliform numbers but showing numbers of coliforms exceeding 5,000 M.P.N. per 100 ml. in more than 20 percent of the samples examined during any one month and not exceeding 20,000 per 100 ml. in more than 5 percent of the samples examined during any month, should be provided auxiliary treatment in addition to filtration and postchlorination. Auxiliary treatment as used here is presedimentation or prechlorination or their equivalents either separately or combined as may be necessary. Long time storage for periods of 30 days or more represents a permanent and reliable safeguard which in many cases would provide something more than an effective substitute for one or both of the two other methods indicated. Waters which do not meet the requirements cited are considered unsuitable for use as sources of water supply unless they can be brought into conformance with the requirements by means of prolonged preliminary storage or some other measure of equal permanence and reliability, as heavy prechlorination and preliminary coagulation and sedimentation.

In addition to the recommended bacterial requirements, waters for public supply should not contain taste producing, toxic, or otherwise harmful substances, or organisms not readily and completely removed by the water treatment processes cited, and should be free of excessive amounts of acid, microscopic organisms, and organic matters causing any interference with the normal operation and efficiency of the water treatment processes. Whether or not upstream domestic and industrial waste is properly treated often determines the acceptability of a stream as a source of domestic or industrial water supply.

Standards adopted by the Public Health Service for Drinking and Culinary Water Supplied by Common Carriers in Inter-State Commerce prescribe limiting maximum concentrations of certain chemical substances inimical to public health, including the following:

Substance	Maximum concentration in parts per million
Lead	0.1
Fluoride	1.5
Arsenic	0.05
Selenium	0.05
Hexavalent chromium	0.05

These standards have received official approval by the American Water Works Association and general acceptance by official health agencies and waterworks authorities and are widely used as one of the guides for administration of water pollution control programs.

Also of importance are those substances which cause taste and odors. Of particular concern are phenolic and related compounds, minute concentrations of which cause repugnant taste and odor in water supplies. Pollution control programs are aimed at virtual elimination of these substances in sewage effluents entering waters serving as a source of domestic supply.

Quality requirements for industrial water supply vary widely, depending upon the type and nature of industry under consideration. Of general concern are organic and biological constituents, toxic substances, and properties of corrosion, encrustation, and slime formation. Waste control measures materially contribute to improvement of these properties.

It is generally agreed that a minimum of 5.0 parts per million of dissolved oxygen is necessary, in those streams of the Upper Missouri River Basin affording a favorable fishery habitat, for support of balanced aquatic life. For trout streams a minimum of 6.0 parts per million is desirable. Because of limited dilution water during critical periods of low flow, secondary treatment, or removal of not less than 75 percent of the Biochemical Oxygen Demand, is required for a few sources of pollution in the Basin. Removal approaching 90 percent is possible with secondary treatment facilities properly designed and well operated.

Contamination of bathing waters by sewage, especially that of recent origin, is objectionable. Water for recreational usage should be free from floating solids, sludge banks, odors, and discoloration. Quality objectives for the bacteriological quality of bathing waters recommended by the Montana State water pollution control agency are as follows:

For bathing or swimming water, monthly arithmetical average 'most probable number' of coliform organisms should not exceed 1,000 per 100 ml. during any month of the recreational season; nor exceed this number in more than 20 percent of the samples examined during any such month; nor exceed 2,400 per 100 ml. on any day. For nonbathing or nonswimming waters, the monthly arithmetical average 'most probable number' of coliform organisms should not exceed 5,000 per 100 ml. in any month of the recreational season, nor should exceed this number in more than 20 percent of the samples examined during any such month. Fecal streptococci are receiving increasing attention, as an index of sanitary quality of bathing water, and sanitary surveys must continue

to play the major role in pollution control programs as related to bathing waters.

For bacteriological quality of irrigation water, the Montana State Board of Health recommends that:

(1) Sewage used for irrigation of forage crops should be given treatment insuring a consistent reduction in coliform bacteria of not less than 90 percent.

(2) Sewage used for irrigation of human food crops should be given treatment insuring a consistent reduction (a) in suspended solids of not less than 75 percent, (b) in 5 day 20° C., B.O.D. of not less than 75 percent, and (c) in coliform bacteria of not less than 98 percent, unless discharged into a stream where the volume of dilution water, available during the low flow periods during which irrigation diversions may occur, is at least 10 times greater than the anticipated maximum daily volume of sewage, in which case a bacterial reduction of 90 percent may be acceptable.

Provided, however, that where the time of passage from plant discharge to irrigation diversion is such as to permit the normal death rate of bacteria as evidenced by the die-away curve to provide equivalent bacterial reduction, the requirement of (1) and (2) above may be appropriately modified.

The protection of water rights must also be considered in determining pollution prevention measures needed. The doctrine of riparian rights, widely applied in States east of the 98th meridian, holds that "all persons owning land abutting on a natural stream have a right to demand that the water shall pass their lands undefiled in quality and undiminished in quantity."[1] Interpretations of the doctrine vary, but in general a "reasonable" approach is applied in which stream uses are permitted which do not substantially lessen its quantity or impair its quality. West of the 98th meridian the doctrine of appropriated water rights is usually accepted, although in many areas State water laws incorporate a portion of both doctrines. Where the doctrine of appropriated water rights prevails, consumptive use of water is permitted but cannot be returned to the stream in a defiled condition. The water laws of Montana are based on the doctrine of appropriated water rights. Water pollution control programs do not interfere with appropriated water rights.

Waste treatment measures are usually tailored to the needs of a community following the engineering evaluation of local sanitary problems. Municipal treatment plants are usually of two general types, one of which removes settleable material from the water under quiescent flow conditions and the other removes polluting material by biological means. Within these categories numerous combinations or adaptions thereof can be used to meet variant conditions of waste from a community and requirements of the receiving stream. Industrial treatment processes vary widely, often within the same general type of

[1]Merriman and Wiggins, American Civil Engineers Handbook, page 1750--Legal and Economic Features of Water Rights, 5th Edition.

industry. Changes in manufacturing processes, by-products recovery, salvage, improved housekeeping, and comparable practices are often very effective measures of controlling industrial pollution. Control of industrial waste may present an entirely different problem than that incurred in municipal wastes, since the wastes may contain toxic or otherwise objectionable substances not amenable to either sedimentation or biological treatment. However, the objective of the control program remains the same--protection of waters by reduction of objectionable substances to within tolerance levels compatible with water uses. The water pollution control program in the Upper Missouri River Basin is based on these premises.

While sewage and waste treatment processes cannot be controlled precisely, they can be regulated between rather well established limits. The effective removal of solids from domestic wastes by sedimentation is termed primary treatment and is generally considered to reduce B.O.D.* from 25 to 40 percent. The removal of Biochemical Oxygen Demand by biological methods is termed secondary treatment. A plant incorporating effective primary and secondary treatment is generally considered capable of removing from 75 to 85 percent of the organic polluting material. Greater reduction, sometimes referred to as tertiary treatment, can be obtained by repetitive passages of wastes through the treatment processes or by increasing the number of combinations of treatment processes. Sewage and waste treatment methods thus defined apply only to organic materials that can be decomposed by biological action or those that may be removed by sedimentation. Inorganic waste such as most acids, alkalies and metallic ions must be controlled by recovery, neutralization, storage, evaporation or other specialized processes. The pollution control program of the Upper Missouri Basin is based upon the following premises:

(1) Toxic substances including metallic ions, phenol compounds, oils, and acids must be excluded from streams. Such substances are inimical to aquatic life and if present in sufficient concentrations are hazardous to human life and to livestock.

(2) Removal of settleable and floating solids to prevent sludge banks, floating materials, and nuisance conditions should be required as the minimum acceptable treatment. Property values, recreation, fishing, stock watering, and other water uses are thus provided a measure of protection.

(3) Treatment required beyond effective removal of solids is influenced by downstream water uses and by the amount of dilution water available during periods of low flow. Biological removal of dissolved organic materials and bacteria must be provided where necessary to: (a) maintain dissolved oxygen at levels necessary for balanced aquatic life; (b) maintain desirable water quality for domestic, industrial

*Biochemical Oxygen Demand is the quantity of oxygen utilized by microorganisms under aerobic conditions while feeding on and stabilizing organic materials under specified conditions of time and temperature.

or recreational uses; and (c) prevent nuisance or other health hazards.

(4) For industrial wastes similar in nature to municipal wastes, treatment should be based on the same premises as that recommended for municipalities. For industrial wastes not similar to municipal wastes, treatment should be provided as necessary to prevent substantial deterioration of water quality for downstream water uses.

The future water pollution control program in the Upper Missouri River Basin should include as its pertinent features:

(1) Enactment of comprehensive pollution control legislation.

(2) Construction of treatment plants where none now exist, and improvement of existing plants where they are presently inadequate to meet needs.

(3) Dissemination of information concerning the effects of pollution on public health, fishing, wildlife, irrigation, livestock watering, industrial water supply, recreation, and other water uses.

(4) Improved maintenance and operation of existing sewage treatment plants.

(5) Periodic surveillance of stream conditions to supplement sewage treatment plant inspections so that needs for improved treatment can be seen well in advance of actual necessity, thus enabling planning and construction to be carried forward with a minimum of delay.

(6) Minimizing the adverse effects of mine wastes in streams through a program of adequate mine waste controls.

Action toward the achievement of a comprehensive stream control program in Montana has begun under the direction of the Montana State Board of Health. Progress will be largely determined by the Board's ability to secure the support of the citizens of the State to provide adequate stream pollution control legislation, funds, and personnel. Water pollution control legislation of the type and scope endorsed by the Council of State Governments is needed in Montana.

The cost of adequate sewage treatment facilities, including original construction cost, operation and maintenance, has been estimated to be between $9 and $15 per year per family, depending upon the size of the community and degree of treatment required. Costs per family are usually lowered as the size of the community increases.

The cost of constructing adequate sewage and industrial waste treatment facilities in the Upper Missouri Basin, including the 15 new municipal plants, 7 enlargements or additions to existing plants, replacement of 11 municipal plants, 3 new industrial waste treatment plants and enlargements to 4 existing industrial plants is

conservatively estimated at $2,850,000. The estimate does not include the cost of trunk sewers to connect treatment works with existing sewer systems, nor does it reflect the cost of operation and maintenance.

Surveys of most of the sources of pollution in the Upper Missouri Basin have been made by the State Board of Health, and reports containing findings of the investigations together with recommendations for correcting or improving conditions have been provided municipal and industrial officials and other interested parties. State reports are available for public inspection. The State Board of Health has further cooperated with representatives of numerous industries and municipalities through conferences regarding specific problems of pollution, and have worked closely with engineers officially employed by the municipalities and industries to study pollution problems. These activities were inaugurated several years ago as a part of a continuing program. Municipal and consultant engineering studies, where conducted, generally substantiate treatment needs as indicated in this report.

The value of supplemental flows from proposed reservoirs as an aid to controlling stream pollution has been recognized by the Montana State Board of Health. It is of considerable importance that this aspect of water use be properly considered in the development of water resources in the Basin.

This report includes no information on pollution contributed to the streams in that portion of the Basin which lies in the Dominion of Canada. The obtaining of such data is beyond the scope of this presentation.

A synopsis of the conditions at municipalities, institutions, and industries of the Upper Missouri Basin as recommended by the Montana State Board of Health is presented:

Dillon, Montana

Considerable quantities of mining wastes consisting of tailings and rock flour are contributed to the headwaters of the Beaverhead River. This waste has allegedly been responsible for reducing the fish population of these streams for considerable distances. It is recommended that better mine waste control methods be practiced to eliminate as much of the harmful materials as possible.

Conditions at the sewer outfall of the City of Dillon become unsatisfactory during that portion of the year when much of the water is diverted from Blacktail Deer Creek above the City of Dillon for irrigation purposes. The sewage produces odorous and unsightly conditions below the city's sewer outlet. Sewage pollution from Dillon also affects the use of irrigation water diverted from the Beaverhead River immediately below Dillon. For these reasons it appears imperative that a sewage treatment works be constructed at Dillon, Montana. Planning toward that goal has already begun by the City of Dillon.

State Orphans Home (Twin Bridges, Montana)

It is appropriate that all State-owned institutions should be provided with treatment facilities; the degree of treatment should be

sufficient to protect water quality consistent with downstream uses. The scenic beauty of the Jefferson River and its tributaries is of great aesthetic value, and it is important that this value be protected. Secondary treatment is recommended.

Whitehall, Montana

The Town of Whitehall constructed a primary sewage treatment plant a number of years ago for the purpose of reducing the amount of settleable material entering the river from municipal sewers. The plant is not operated efficiently at the present time. Treatment would be improved by better operation.

Montana State Training School (Boulder, Montana)

Sewage treatment facilities at Montana State Training School, located in Boulder, produce an unsatisfactory effluent which is discharged to the Boulder River. There is considerable irrigation below the school, water for which is contaminated by this sewage. A new treatment plant is recommended for the State Training School. It has been reported that considerable damage to fishlife in the headwaters of Boulder River has occurred as a result of mining operations. In order to protect the fishlife in the Boulder River it will be necessary to control pollution from both the mines and the Montana State Training School. There has been no action taken towards providing such controls.

Three Forks, Montana

At the present time the municipality of Three Forks is discharging untreated wastes to the Madison River just above the junction of the Madison, Jefferson, and Gallatin Rivers. Primary treatment of the municipal sewage is recommended by the State Board of Health.

Bozeman, Montana

The City of Bozeman employs primary sewage treatment. The plant is well designed and well operated. The plant effluent is discharged to the East Gallatin River without apparent damage to the stream. The Bozeman pea cannery located a short distance from the city sewage treatment plant is contributing during its period of operation considerably more waste than does the city. The cannery wastes are discharged to the stream after minor treatment and are responsible for a rather serious pollutional condition in the East Gallatin River immediately below the outfall. It is therefore essential that cannery wastes receive treatment comparable to secondary treatment.

Belgrade, Montana

The Town of Belgrade has a primary treatment plant which is overloaded and unsatisfactorily operated. The replacement of this plant with a modern primary treatment plant is necessary before adequate treatment of municipal wastes can be effected.

Manhattan, Montana

The situation at Manhattan is much the same as that at Belgrade, and the replacement of the present treatment works is necessary to protect the extensive water uses in this area. These uses include water for livestock, irrigation, fishing and other forms of recreation.

Townsend, Montana

The City of Townsend constructed a primary sewage treatment works which is now inadequate to handle the present sewage load. It is necessary to provide additional units in order to prevent excessive amounts of unsightly and harmful material from entering the river. The public health aspect of sewage treatment at Townsend may become increasingly important as recreational facilities are established at the Canyon Ferry Reservoir.

East Helena, Montana

The municipality of East Helena has a sewage treatment plant which in recent years has become grossly overloaded. Insufficiently treated sewage is discharged to Prickly Pear Creek and, together with sewage from Helena, has caused much damage to agriculture and fishing. The East Helena sewage treating plant should be enlarged so that it will be possible to reduce the amount of polluting material entering the creek. Industry in the vicinity of East Helena contributes very little waste to watercourses.

Helena, Montana

The conditions at Helena are quite extensively described on page 19 of the report. It will be necessary to construct a plant which will provide sewage treatment to a degree compatible with present uses of water in Ten Mile Creek, Prickly Pear Creek, and Lake Helena. The design of such a plant has been approved by the Montana State Board of Health.

Veterans Administration Hospital, Fort Harrison, Montana

The Veterans Administration Hospital located at Fort Harrison is discharging insufficiently treated sewage into Ten Mile Creek above Helena. The plant should be replaced with one providing secondary treatment.

Cascade, Montana

The Town of Cascade does not have a treatment works but has plans for constructing such facilities. The Montana State Board of Health recommends primary treatment.

White Sulphur Springs, Montana

The Town of White Sulphur Springs has a septic tank, but during recent years has allowed the wastes to by-pass the tank and consequently reach the Smith River without treatment. Septic tanks are not generally considered capable of satisfactory treatment, therefore it is recommended that an entirely new plant incorporating secondary treatment be constructed. The rather serious pollution in the Smith River below the outfall has damaged fishlife and irrigation waters diverted from the river immediately below the town.

Great Falls, Montana

The City of Great Falls is the largest municipality in the Basin and is essentially an industrial center. The principal industry is that of copper refining, however meat packing, flour milling, and oil refining industries are also present. The wastes from industry and that from the 39,000 inhabitants are discharged into the reservoir formed by the Montana Power Company dam above Black Eagle Falls in the Missouri River. Floating solids and oil are evident in the reservoir which has become an area where wastes from the populace and industries of Great Falls are undergoing decomposition. The abatement of pollution in this part of the Missouri River would allow the return of recreational values and remove a hazard to the Fort Benton water supply. Primary treatment of sewage and equivalent treatment of industrial wastes at Great Falls is needed.

Fort Benton, Montana

This city of 1,500 inhabitants discharges its sewage directly to the Missouri River without benefit of treatment. Primary treatment is recommended by the Montana State Board of Health.

Glacier Park Station

This community of 200 persons has been provided with sewage treatment. The effluent from the plant is discharged into Medicine Creek. The present plant, however, does not provide the desired degree of treatment, and the installation of additional facilities has been recommended by the Montana State Board of Health.

Browning, Montana

The Town of Browning and the Cut Bank Boarding School located near Browning have sewage treatment facilities. The plant at Browning is not entirely satisfactory. Enlargement of the plant is recommended by the State water pollution control agency. Satisfactory primary treatment is important since the water of Cut Bank Creek supplies the domestic needs of the City of Cut Bank.

Blackfoot Indian Agency

The Blackfoot Indian Agency is located near Browning but discharges its sewage to a small stream tributary to Cut Bank Creek. The Agency provides sewage treatment which is unsatisfactory. Replacement with secondary treatment has been recommended.

Cut Bank, Montana

The City of Cut Bank has a sewage treatment works which has been greatly overloaded and is grossly inadequate to meet the needs. It has been recommended that the present works be replaced by a secondary treatment plant. The value of the waters of Cut Bank Creek for irrigation, livestock watering, and fishing is sufficient to provide a reasonable basis for this conclusion. The Union Oil Refinery located near Cut Bank has provided ample facilities to control its wastes. No wastes from the refinery reach the watercourse at the present time.

Shelby, Montana

The Town of Shelby, with a population of 3,000 persons, discharges raw sewage through a long ditch to the Marias River. The Montana State Board of Health recommends that secondary treatment facilities be provided. Local nuisance conditions and increased use of water below Shelby warrant the treatment recommended.

Chester, Montana

The Town of Chester discharges untreated waste to Cottonwood Creek, a small tributary of the Marias River. The municipality is preparing plans for secondary treatment.

Conrad, Montana

This town of 1,800 persons is served by a sewage treatment plant, however the present plant is inadequate and the State Board of Health has recommended that it be replaced. The town is proceeding with plans to provide primary treatment.

Choteau, Montana

Replacement of the present Choteau sewage treatment works is considered essential to correct present inadequacies. The plant discharges effluent to the Teton River, which is used quite extensively as a fishery and is a source of water for livestock. The protection of these uses from further deterioration due to pollution is considered essential, and it is recommended that a primary sewage treatment works be constructed.

Geraldine, Montana

The Town of Geraldine has a sewage treatment plant which is grossly inadequate and is of little value. It is recommended that the present primary works be enlarged to provide the essential treatment. No action has been taken by the municipal authorities to carry out this proposal.

Lewistown, Montana

This city of 6,500 inhabitants has sewage treatment, however the rapid growth in recent years has greatly overloaded the plant and thereby reduced the efficiency to a point where it is of little use.

The value of the fishery of Big Spring Creek into which the wastes of Lewistown are discharged should be protected from deterioration by adequate sewage treatment. The Montana State Board of Health recommends secondary treatment units at the Lewistown plant.

Harlowton, Montana

The City of Harlowton discharges inadequately treated sewage to the Musselshell River. The river is used extensively below Harlowton as a source of irrigation water, and as a source of rural drinking water supplies. The river also supports a considerable fishery and is a source of water for livestock. The protection of these uses from further deterioration due to pollution is considered essential, and it is recommended that a new sewage treatment works be constructed at Harlowton to replace the present plant. In addition to municipal waste, considerable quantities of oil are discharged to the river by the Chicago, Milwaukee, St. Paul & Pacific Railroad maintenance shops. Corrective action to be taken at the railroad maintenance shops, when determined by the State Board of Health, should be carried out.

Judith Gap, Montana

Existing sewage treatment facilities at Judith Gap are considered satisfactory to meet the present needs. The efficiency of the plant, however, could be improved by better operation.

Roundup, Montana

The rather extensive diversion of water from the Musselshell River below Roundup for irrigation and rural domestic water supply indicates that adequate sewage treatment is essential. Other uses which would be protected by such action include fish propagation and the watering of livestock. The existing sewage treatment plant at Roundup is inadequate to meet the needs. It is recommended that present facilities be replaced by a modern treatment plant. No action has been indicated by the city.

Winnett, Montana

This town of about 400 inhabitants has a primary treatment plant which is poorly operated and considered inadequate to prevent the pollution of the small creek into which the effluent is discharged. It is recommended that the plant be replaced. No action toward planning the improvements has been indicated by the town authorities.

Big Sandy, Montana

The Town of Big Sandy has sewage treatment facilities which are incapable of producing a degree of treatment compatible with water usage in Big Sandy Creek. It is essential that the present plant be replaced by one employing secondary treatment. Downstream water uses include livestock watering and irrigation. No action towards the installation of corrective measures has been taken by the city authorities.

Malta, Montana

Malta, population 2,000, discharges untreated sewage to the Milk River. A considerable quantity of water is diverted below Malta for irrigation and incidental rural water supplies, and it is essential that sewage be treated for the protection of these interests. A new sewage plant incorporating primary treatment is recommended for Malta. The city authorities have not yet indicated action towards achieving the improvement.

Saco, Montana

The domestic sewage from Saco is discharged into Beaver Creek without treatment. Here, as at Malta, protection of water diverted for irrigation and other uses is essential. Secondary treatment facilities are therefore recommended. No action has yet been taken by the town authorities to comply with this proposal.

Hinsdale, Montana

The primary sewage treatment facilities at Hinsdale need additional primary units and better operation.

Glasgow, Montana

This city of 3,800 inhabitants discharges raw sewage to the Milk River. Diversion of water from the river immediately below the city for irrigation and associated uses creates a need for sewage treatment at Glasgow. Primary treatment is recommended.

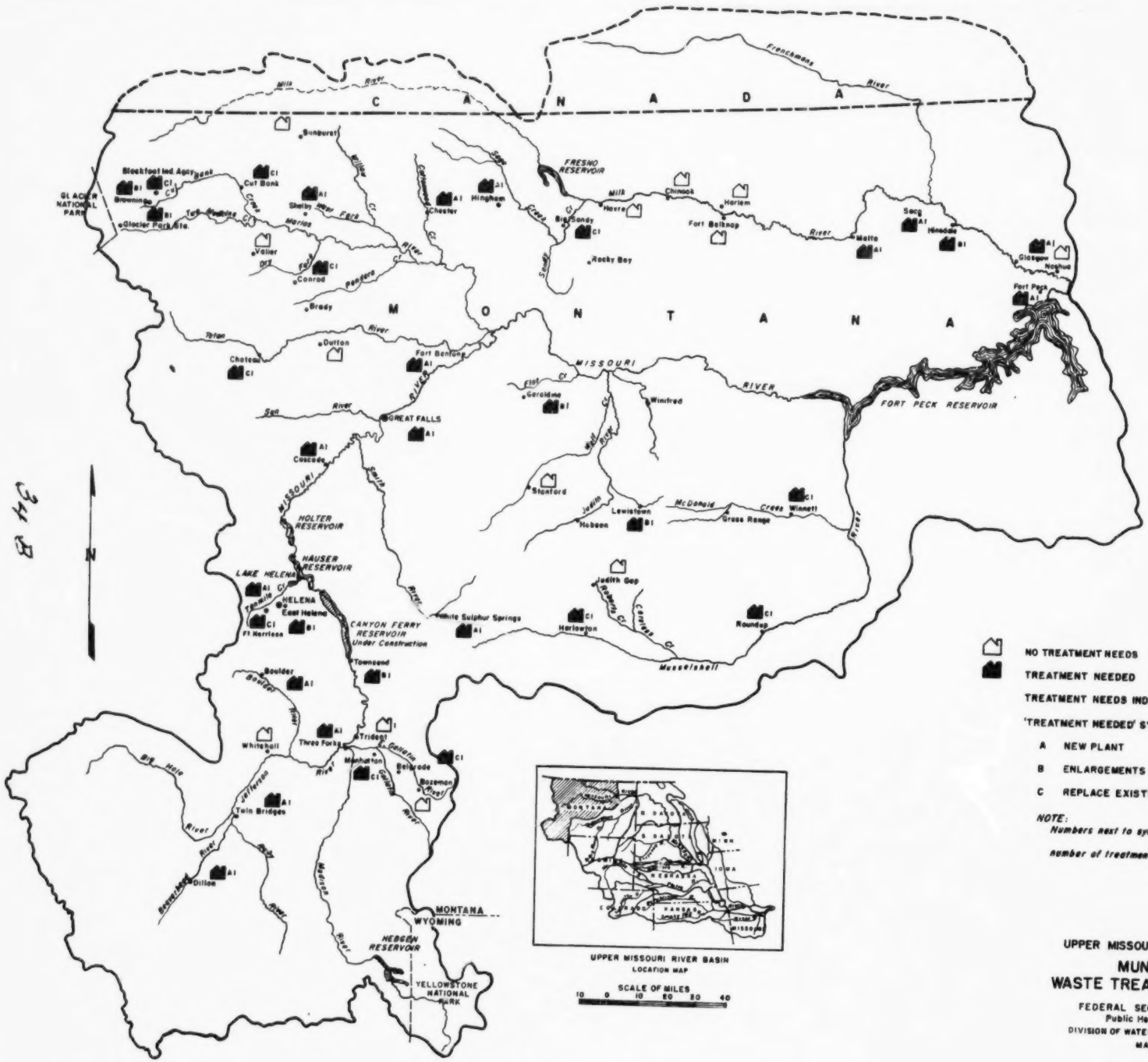
Nashua, Montana

The Town of Nashua has provided sewage treatment which is considered generally adequate to meet the needs. The efficiency of the plant could be improved by better operation.

Fort Peck, Montana

The Town of Fort Peck is not provided with sewage treatment facilities; raw sewage is discharged to the Missouri River. The Montana State Board of Health recommends that primary treatment be provided for Fort Peck sewage.

Tables 12 and 13 summarize treatment needs in the Basin and the action taken by the municipalities and industries towards achieving pollution control. These needs are depicted on maps 5 and 6.



UPPER MISSOURI RIVER BASIN
LOCATION MAP

SCALE OF MILES
10 0 10 20 30 40

NO TREATMENT NEEDS

TREATMENT NEEDED

TREATMENT NEEDS INDICATED BY LETTERS APPEARING BELOW 'TREATMENT NEEDED' SYMBOLS, AS FOLLOWS:

A NEW PLANT

B ENLARGEMENTS OR ADDITIONS TO EXISTING PLANT

C REPLACE EXISTING PLANT

NOTE:
Numbers next to symbols or next to code letters represent number of treatment needs in the category designated

UPPER MISSOURI RIVER BASIN
MUNICIPAL WASTE TREATMENT NEEDS

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 5

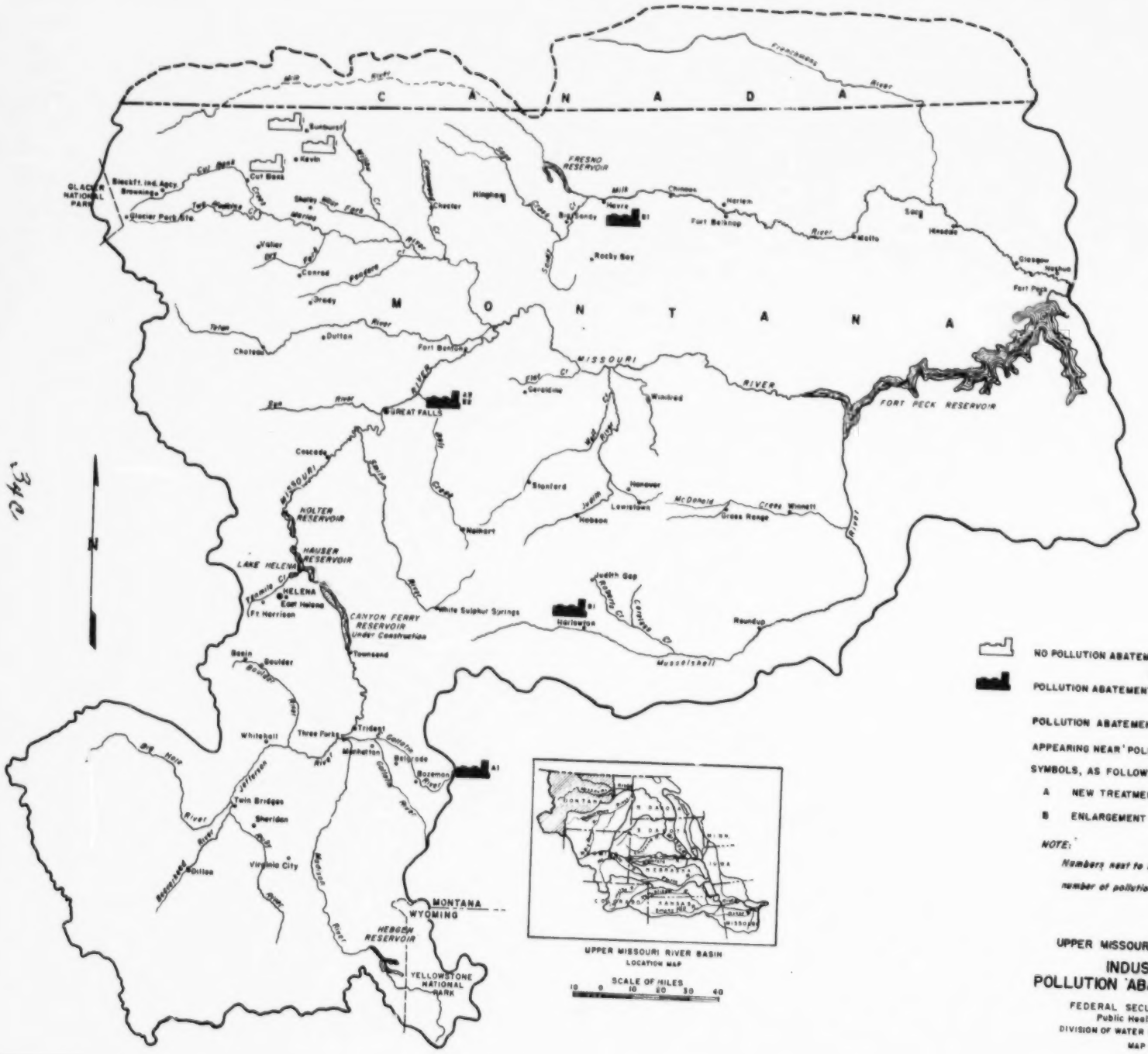

C A N A D A
MONTANA
MISSOURI RIVER
FORT PECK RESERVOIR
FRESNO RESERVOIR
GREAT FALLS
HOLTER RESERVOIR
HAUSER RESERVOIR
LAKE HELENA
HELENA
CANYON FERRY RESERVOIR
Under Construction
Townsend
Three Forks
Whitehall
Twin Bridges
Sheridan
Dillon
Virginia City
Belgrade
Bozeman
Manhattan
Trident
Boulder
Basin
Jefferson River
Big Hole River
Beaverhead River
Madison River
Gallatin River
Missouri River
Milk River
Marias River
Teton River
Sun River
Dearborn River
Judith Gap
Harlowton
White Sulphur Springs
Roundup
Musselshell
Stanford
Hobson
Lewistown
Hanover
McDonald
Grass Range
Winnett
Creek
Malmart
Geraldine
Winifred
Fort Benton
Chester
Kingsbury
Havre
Chinook
Harlem
Fort Belknap
Malta
Saco
Hinsdale
Glasgow
Nashua
Fort Peck
Rocky Boy
Conrad
Dutton
Choteau
Cascade
Kevin
Sunburst
Cut Bank
Shelby
Valier
Browning
Blackft. Ind. Agcy
Glacier Park Sta
GLACIER NATIONAL PARK
MONTANA
WYOMING
HEBGEN RESERVOIR
YELLOWSTONE NATIONAL PARK
N
UPPER MISSOURI RIVER BASIN
LOCATION MAP
SCALE OF MILES
10 0 10 20 30 40
NO POLLUTION ABATEMENT NEEDS
POLLUTION ABATEMENT NEEDED
POLLUTION ABATEMENT NEEDS INDICATED BY LETTERS APPEARING NEAR 'POLLUTION ABATEMENT NEEDED' SYMBOLS, AS FOLLOWS:
A NEW TREATMENT PLANT
B ENLARGEMENT OR ADDITIONS TO EXISTING PLANT
NOTE:
Numbers next to symbols or code letters represent number of pollution abatement needs in the category designated
UPPER MISSOURI RIVER BASIN
INDUSTRIAL
POLLUTION ABATEMENT NEEDS
FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 6

Table 12. Upper Missouri River Basin - Needs for municipal and industrial waste treatment plants

	Municipal		Industrial
Needs	Number	Population served by facilities	Number
New plant	15*	75,950	3
Enlargement or additions to existing plant	7	11,820	4
Replace existing plant	11	14,620	0
No project required	13	28,370	3
Undetermined	0	0	0

*Includes 5 where plants have been previously installed but which must be completely new, therefore the State considers them to be new plants needed rather than replacements.

Table 13. Upper Missouri River Basin - Current status of municipal and industrial action on pollution abatement needs

Status of project	Number of municipalities	Number of industries
No action	27	7
Abatement ordered	0	0
Final plans approved	1	0
Construction awaiting financing	0	0
Under construction	0	0
Status undetermined	0	0
Planning initiated	5	0

APPENDIX A

MONTANA WATER POLLUTION CONTROL LEGISLATION

I. General Statement

The State Board of Health has "general oversight and care" of all waters used as sources of water supply for domestic purposes; and of all waters "with respect to their condition and use as affecting the public health."

At its 1949 session, the legislature adopted the Council of State Governments' draft Water Pollution Control Enabling Act (Ch. 184, Laws 1949). Other statutes relating to water pollution control are collected in Ch. 13, Tit. 69, Rev. Codes, 1947. Statutes relating to the organization of the State Board of Health and its general powers and duties are collected in Ch. 1, Tit. 69, Rev. Codes, 1947, as amended by Ch. 57, Laws 1949. Apart from these laws, which are directed to the control of pollution in waters used for domestic purposes, criminal statutes make it unlawful to put dead animals, offal, etc. in all streams, ponds, lakes, or reservoirs (Sec. 94-3542, Rev. Codes, 1947); to deposit coal slack in any stream (Sec. 94-3551, Rev. Codes, 1947); and to poison any well, spring, or reservoir (Sec. 94-35-255, Rev. Codes, 1947).

The State Board of Health has been designated by the Surgeon General as the water pollution control agency for the State.

II. Administrative organization

The State Board of Health consists of seven members (Sec. 69-102, Rev. Codes, 1947, as amended by Sec. 2, Ch. 57, Laws 1949).

The Board's jurisdiction in the area of water pollution control is Statewide.

There is an office of executive director within the Board, and the person holding that office is the administrative and executive head of the Board. Each division and section of the Board is responsible to the executive officer (Sec. 69-103, Rev. Codes, 1947, as amended by Sec. 3, Ch. 57, Laws 1949). Water pollution control activities are centered in a division of sanitary engineering, apparently created by administrative action.

The executive officer appoints all subordinate personnel with the consent of the Board, subject to provisions of the merit system (Sec. 69-103, Rev. Codes, 1947, as amended by Sec. 3, Ch. 57, Laws 1949). There are no specific provisions for delegations of authority.

There is no advisory council.

III. Powers and duties

1. Development of comprehensive program.

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The Montana laws do not specifically provide for the development of a comprehensive program, nor for the setting of standards of water purity, nor for classifying waters. The Board of Health's authority, however, is broad. It is given "general oversight and care of all inland waters, streams, lakes, and ponds used as sources of water supply" (Sec. 69-1301, Rev. Codes, 1947); it may "cause examination of waters to be made to ascertain their purity and fitness for domestic use, or their liability to impair the interests of the public, or of persons lawfully using them, or to imperil the public health" (Sec. 69-1302, Rev. Codes, 1947); it may make rules and regulations to prevent pollution and "to secure the sanitary protection of all waters as are used for domestic purposes" (Sec. 69-1302, Rev. Codes, 1947); it shall make and publish in a monthly bulletin "rules and regulations for the collection of samples and analyses of water, either natural or treated" (Sec. 69-1304, Rev. Codes, 1947).

2. Issuance of permits and review of plans and specifications.

"Cities, towns, and all other corporations, companies, or persons shall submit to said Board, for its advice and approval, their proposed system of water supply, or of the disposal of drainage or sewage, and no city, town, or person or company shall proceed to build or install or enlarge or extend any system of water supply, drainage, or sewage disposal, without first obtaining the approval of the State Board of Health" (Sec. 69-1308, Rev. Codes, 1947; see also Sec. 69-125, Rev. Codes, 1947).

Municipal and private corporations and persons intending to construct any railroad, logging road, logging plant, electric plant, or manufacturing plant upon the watershed of any public water supply system must first furnish the State Board of Health with detailed plans and specifications of the sanitary precautions to be taken which must be approved by the Board (Sec. 69-1310, Rev. Codes, 1947).

Anyone drilling a water well intended for use by the public shall furnish the Board of Health with such information as the Board may by rule or regulation require (Sec. 69-1311, Rev. Codes, 1947).

3. Enforcement

Upon a complaint the State Board may issue orders prohibiting the continuance of any pollution and requiring the removal of any cause of pollution (Sec. 69-1314, Rev. Codes, 1947). Presumably the Board may also issue orders on its own motion.

Administrative hearing is not required prior to issuance of the Board's orders. Miles City v. State Board of Health, 102. Pac. 696.

Persons aggrieved by any order of the Board may appeal to the district court (Sec. 69-1316, Rev. Codes, 1947). In the case of an appeal by a city or town, the statute is express that the case shall be tried de novo (Sec. 69-125, Rev. Codes, 1947).

Upon application of the State Board of Health or of any person interested, the district court of any county has jurisdiction in equity to enforce the Board's orders, rules and regulations (Sec. 69-1317, Rev. Codes, 1947). The Board has general authority to bring actions in the courts for the enforcement of the public health laws and the Attorney General is required to bring all suits and actions ordered by the Board (Secs. 4 and 6, Ch. 57, Laws 1949).

Violation of any provision of the act or of any rule, regulation or order of the State Board of Health is punishable by fine or imprisonment (Sec. 69-1320, Rev. Codes, 1947).

4. Conduct of studies, investigations, and research.

The Board of Health is authorized to establish and maintain an experiment station for the purpose of studying the best methods of preventing pollution, for the purification of water, and for the purification, disinfection, and disposal of sewage and domestic and manufacturing waste (Sec. 69-1318, Rev. Codes, 1947).

5. Cooperation with other public and private agencies.

Under the Council of State Government's draft enabling act passed by the last legislature, the State Board of Health has uthority to take any action necessary to secure to the Sta. the benefits of the Federal Water Pollution Control Act, to cooperate with other agencies and to enter into agreements with other States (Ch. 184, Laws 1949).

6. Administrative powers.

Under its general powers the State Board of Health has authority to hold hearings, administer oaths, subpoena witnesses, and to take testimony in all matters relating to the exercise and performance of its powers and duties (Sec. 4, Ch. 57, Laws 1949).

The Board has investigatory and visitorial powers (Secs. 69-1301, 69-1302, 69-1304, 69-1308, 69-1314, 69-1315, Rev. Codes, 1947).

No special procedures are provided in relation to the making of orders, granting of permits, the issuance of rules and regulations. Requirements respecting publication of orders, rules and regulations are contained in Sec. 69-1303, Rev. Codes, 1947.

IV. Exemption from operation of act

There are no exemptions specified.

V. Preservation of existing rights and remedies

None.

VI. Statement of policy, severability clause

No general statement of policy is set forth in the laws. The enabling act contains a severability clause (Ch. 184, Laws 1949).

VII. Interstate agencies

The State is not a member of an interstate agency.